PETHA WASTE MANAGEMENT IN AGRA CITY

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Contents

Prelude

Agra, in the north Indian state of Uttar Pradesh, is a culturally rich and historically important city. As per the Archaeological Survey of India's classification, it has 48 protected monuments of which one—the Taj Mahal, built in the seventeenth century AD by Emperor Shahjahan in memory of his beloved wife Mumtaj—is among the new Seven Wonders of the World. There are also two more world heritage sites in and around Agra city, viz. Agra Fort and Fatehpur Sikri. Akbar's Tomb at Sikandara and the Itmad-ud-Daula's tomb in Agra are also proposed to be World Heritage sites.

Agra, spread over an area of 120 sq. km, has a population of about 1.58 million people that reside within the municipal limits (as per Census 2011) and an additional floating population of 0.3 million (as per Agra Jal Sansthan). According to the Agra Smart City project, the city hosts 17 per cent of the total international tourists visiting India every year (which is estimated to be close to 1.15 million).

The city has four administrative zones that are further divided into 100 wards. It generates municipal solid waste of around 796.3 tonnes per day (TPD). Per capita waste generation is 0.37–0.45 kg.[1] Agra Municipal Corporation faces a huge challenge in providing basic civic amenities such as sanitation and waste management services to the citizens and the floating population.

The Taj Mahal and other historical monuments attract domestic as well as international tourists. Another attraction of the city is its petha sweet. Agra's petha is most sought after even though other varieties are available in most Indian markets.

Petha sweet is a soft, translucent candy made from winter melons (ash gourd). According to locals, this is the purest form of sweet—its ingredients are just ash gourd, sugar syrup and water. The legacy of Agra petha goes back almost four centuries when it was served as an instant source of energy to the thousands of workers engaged in the construction of the Taj Mahal. Petha was made in the royal kitchens during the reign of Shah Jahan.

Evolution of petha

The exact origin of petha is unknown. Its history however is linked with the Mughal Empire. Around the sixteenth century, during the reign of Emperor Jahangir, Agra was the capital of the Mughal Empire. It is believed that Queen Nur Jahan tasted petha at the market—which was later in her honour named Noori Darwaza and is currently known as Noori Gate—and decided to take the cuisine to her royal kitchen.

The first iteration of petha sweet is believed to have been 'gulabi' (or rose) and is assumed to be over a thousand years old. Queen Nur Jahan's encouragement led to the current form of petha, considered as the original form. Over the last few centuries—and especially in the last few decades—several flavours of petha, such as paan, chocolate, kesar, angoori, mango and coconut, have been created.

It is hard to believe that the vegetable ash gourd transforms into the crystalline and translucent petha sweet. Ash gourd—the botanical name is *Benincasa hispida*—is believed to have significant curative properties.[2]

Table 1: Nutritional composition of ash gourd (nutritional value per 100 gm)

Parameter	Value
Energy	54 KJ (13 Kcal)
Carbohydrates	3 gm
Fat	0.2 gm
Protein	0.4 gm
Calcium	19 mg (2%)
Iron	0.4 mg (3%)
Magnesium	10 mg (3%)
Manganese	0.058 (3%)
Phosphorous	19 mg (3%)
Sodium	111 mg (7%)
Zinc	0.61 mg (6%)
Thiamine (Vit B1)	0.04 mg (3%)
Riboflavin (Vit B2)	0.11 mg (9%)
Niacin (Vit B3)	0.4 mg (3%)
Pantothenic Acid (Vit B5)	0.133 mg (3%)

Source: Sherin A. Salam, July 2014, Ash Gourd, Kerala Karshakan e-Journal, Volume 2 Issue 2, pp. 22–28

Petha has a multitude of nutritional and medical benefits and is an affordable source of instant energy. Ash gourd is rich in calcium, minerals and carbohydrates. It is also known to act as a blood coagulant and used in the treatment of peptic ulcers and obesity. Petha

products are recommended for growing children and lactating mothers, and during jaundice because of their richness in glucose and minerals.[3] Petha also helps nourish the brain and enhance the nervous system.

Due to its cooling properties petha is protective in summer. Although it has a high content, the preparation of petha does not involve the use of cooking oil, so it has a negligible fat content and is free from cholesterol.

Agra petha has its own recipe and is popular among the city residents as well as the large number of visitors. Agra ka petha (i.e. petha of Agra) is instantly identified—along with the iconic Taj Mahal—with the city that is home to one of the new Seventh Wonders of the World.

Key ingredients of petha sweet

a. Ash gourd

Ash gourd is the key ingredient for petha sweet. Farmers or distributors generally buy it from vegetable wholesale markets. The whole batch of ash gourd is sold on the basis of the daily market price. During high-production season (summer) the price can be as low as Rs 270–310 per mann (40 kg). The restrictions on transportation due to the Covid-19 pandemic, however, pushed the price up to Rs 400–410 per mann.

b. Sugar

Sugar is the most important raw material after the ash gourd. Along with sweetening the petha, it also gives it a hard coating. Refined mill sugar is the used most often as the sweet requires a clear sugar syrup with the least impurities.

c. Calcium carbonate

Calcium carbonate—also known as lime—is used for tightening or firming processed petha. Lime water is prepared by soaking of 1–2 kg of lime in 15–20 litres of water for two to three hours per 100 kg of petha and then removing undissolved lime from the solution.

d. Skimmed milk

Skimmed milk is added to clean the sugar syrup. The protein in the skimmed milk binds with impurities in the boiling sugar syrup, rises on top and floats as scum, which can be removed using big slotted ladles. Skimmed milk is used as otherwise the fat in the milk will interfere in the binding process of the skimmed milk protein and reduce flocculation.

e. Alum (fitkari)

Alum is added to separate dirt and extraneous matter when preparing sugar syrup with unrefined sugar.

f. Colouring and flavouring agents

To give petha specific colours, colouring agents are added. Flavouring agents are added to enhance palatability. Colour is added to the boiling syrup to ensure that the colour penetrates to the core of the whole petha. The colouring should be heat stable. Some common varieties of synthetic colours used in the preparation of petha are kesari powder, apple green powder and orange-red powder. Flavours, either natural or synthetic, are added to the coloured petha. Cardamom seed powder, saffron and gulkand are examples of natural flavours.

g. Water

The preparation of petha—right from cleaning the ash gourd to separating dirt from the syrup—involves extensive use of water. Water quality is of great importance in determining the quality of the product. Due to the natural hardness of groundwater, most petha makers use it to soak the pieces and use the water supplied by Jal Nigam to make syrup and boil petha pieces.

As much as 500–600 litre of water is required to make about 100 kg of petha (see *Table 2: Estimate for making 100 kg of petha*).

Table 2: Estimate for making 100 kg of petha

S. no.	Raw material	Approx. quantity	Approx. cost (in Rs)
1.	Ash gourd	150–200 kg	1,500–2,000
2.	Sugar	50–60 kg	1,500–2,000
3.	Lime	1–2 kg	10–20
4.	Skimmed milk	100–200 ml	5–10
5.	Alum	25–50 gm	5–10
6.	Water	500–600 l	NA

Source: CSE 2021

The process of making petha

Preparing sugar syrup

Supply water is used to make sugar syrup. If twigs or stones are found in the vessel they are removed and the sugar syrup is heated. After the sugar dissolves, the mixture is brought to a simmer and stirred continuously. Skimmed milk is added while stirring continuously and the mixture is boiled. After some time, white scum floats to top of the vessel, and is removed with a ladle and collected in another small vessel.

A solution is later prepared using water and alum so that a thick scum layer forms over the solution. It is boiled for required concentration so that the water evaporates. Artificial colour and flavours are added to make flavoured petha and the solution is stirred.

For plain petha, the solution is transferred to another holding vessel lined with muslin cloth to separate any particulate matter. The prepared syrup is stored until the petha pieces are boiled.

Process

- Generally, one batch of ash gourd is processed at a time for the production of petha. Initially, ash gourds are washed properly with groundwater to remove any dirt or extraneous matter. The washing helps identify spoiled, abrasive, damaged, over-ripened or mechanically damaged ash gourd and these are rejected.

- After the ash gourd is cut, the pulp is mashed and seeds separated from it by means of blunt blades.

- The petha slices are cut into desired shapes using a standard sharp-edged knife. After it is sliced to small pieces, the petha is peeled to ensure that no green residue remains on the pieces. The petha that remains after moulding is grated and mixed with rose flavour and red colour to get the value-added gulaab lacchha petha.

- Once the slices are in the desired shape for efficient boiling and for ensuring proper seepage of syrup, the pieces are pricked using handheld pokers or poking machines.

- The ash gourd is then soaked in tanks filled with lime water; the process takes two to three hours. After this, the petha pieces are washed thoroughly to remove any excess lime accumulated on it.

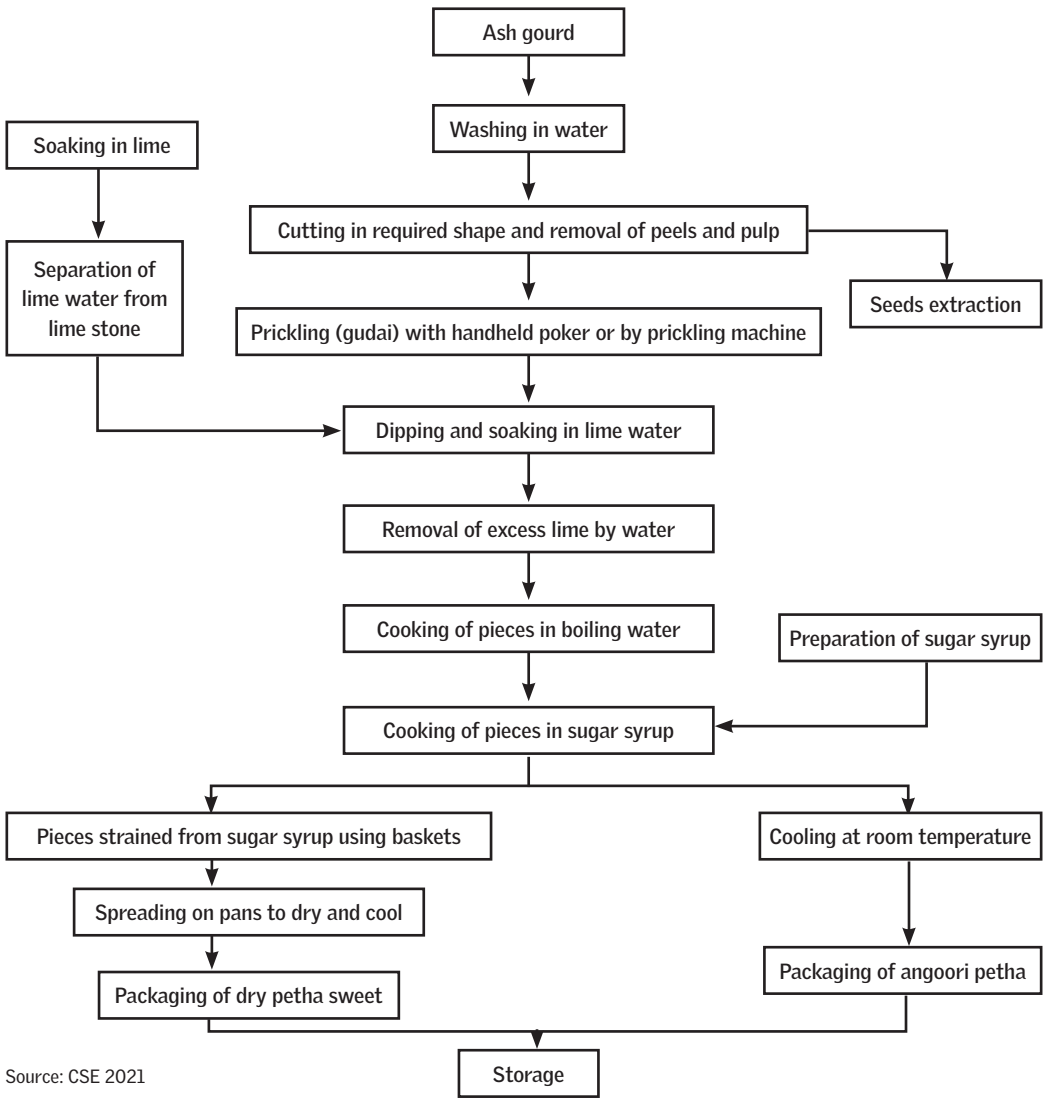
- The petha is then boiled in water to remove any vegetable odour from the pieces and to clean surface pores before the syrup is absorbed. The prepared and stored syrup is poured into the cooking vessel with strained and boiled pieces of ash gourd.

- The batch is boiled for proper seepage of syrup. For flavoured petha, colour and flavours are added to the syrup.

For dry petha

- After the petha pieces are cooked, they are taken out of the vessel with slotted ladles to remove excess sugar syrup inside them. The pieces are transferred to large trays where they are moved around with ladles to ensure that most of the heat escapes from the surface of the petha pieces. If they are not moved around the tray, they could stick together after cooling and packaging becomes very difficult.

Figure 1: Process for making petha



Source: CSE 2021

- After the syrup on the outside hardens, the trays are transferred to racks where the petha pieces reach room temperature. After the petha cools it is packed in cardboard boxes lined with polythene film.

For wet (angoori) petha

- For wet petha, the pieces are transferred to a vessel along with small cherries for kesari petha and syrup is added. It is then allowed to cool down to room temperature.

- After the pieces cools down to room temperature, they can be packed in polypropylene pouches with syrup, while ensuring that most of the air is removed from the pouch before sealing. These sealed pouches are then packed into individual cardboard boxes to ensure that they do not get damaged during handling

Shelf life of petha

Table 3: Shelf life of petha at room temperature and when refrigerated

Storage type	Wet petha	Dry petha
Room temperature	7–10 days	15–20 days
Refrigerator	10–15 days	25–30 days

Source: CSE 2021

- The shelf life depends upon various factors such as hygiene conditions, season—petha lasts longer in winter than in summer—and package handling.

- It is advisable to check the organoleptic characteristics before consuming old petha.

Objective of the study

Managing petha waste has traditionally been a challenge for the Agra Municipal Corporation. The waste floods dhalaos, drains and streets in the neighbourhoods of the petha makers.

This study examines the fate of waste generated during the process of making petha and beyond its shelf life in Agra city. It also studies the current practices of petha makers in managing the waste generated in the process of preparation. The study also looks at the existing mechanism followed by Agra Municipal Corporation to collect, transport and treat petha waste.

There are two types of petha waste:

1. **Raw petha waste,** generated during the process of making petha sweet and comprising mostly peels and pulp, including seeds.

2. **Petha sweet waste**, generated when petha sweet reaches end of its shelf life.

This study focuses on the waste generated during the process of petha making, i.e. waste from raw petha. It does not include waste generated beyond shelf life of the sweet, which varies from seven to 30 days (depending on type of sweet). Given the buffer in the shelf life of petha,waste emanating from finished petha sweet is meagre.

The objective of the study can therefore be summarized as the following:

- To estimate petha waste generation in Aga city;

- To analyse the current practices for managing petha waste; and

- To recommend sustainable solutions for managing petha waste.

Status of petha waste management in Agra

Petha sweet is popular all over India. Its manufacture has been replicated in many parts. Agra petha is, however, the most popular because of its origin, taste, quality and variety. Panchhi Petha and Pracheen Petha are widely known brands and their businesses are well established. They are not only sold locally and nationally but also exported in international markets.

According to the Petha Association of Agra, there were more than 700 manufacturing units in 2013.[4] According to a study conducted by Sharda University, around 1,500 petha-making units generated 700–800 tonnes of petha waste daily.[5] Most of the manufacturing units have, however, moved outside the city after the ongoing intervention of the Agra Municipal Corporation following the judicial directives. The Covid-19 pandemic has also severely affected the demand for petha sweet, and many petha units have shut down.

Table 4: Quantity of waste generated to produce 100 kg of petha sweet

Raw ash gourd used (in kg)	150–200
Petha waste generated (in kg)	60–80

Source: CSE 2021

According to the Association of Petha Makers and extensive field survey, there are about 130 petha-making units currently operational, producing around 26.8 tonnes of petha per day and generating around 17.8 tonnes of petha waste per day. Skilled petha workers with two to three years of experience had started their own businesses pre-Covid—contributing to the increase of small petha-makers in Agra—but due to low market conditions and the pandemic they have temporarily shut down their units.

In September 2012, the Agra Muncipal Corporation, following the judicial directives,[6] ordered all petha makers to shift to Kalindi Vihar, around 11 km from the current location at Noori Gate. Most petha makers made the sweet on coal or wood fires, a potential source of pollution. The order came after the Supreme Court observed the high rate of pollution in the Taj Trapezium Zone. But despite specific judicial directives and notification by the Agra Municipal Corporation, few petha makers shifted their business to the new location at Kalindi Vihar.

This study found that the following factors contributed to the inaction of petha makers:

- Making petha sweet requires a certain standard in water quality (see *Table 5: Parameters of quality of supplied water and groundwater*). The water quality at Kalindi Vihar was a major concern as it was not meeting the standard needed for making petha sweet. This became apparent when the petha makers who relocated to Kalindi Vihar experienced problems with water quality and had to procure water by water tanker from Agra city. At Noori Gate and other locations such as Lohamandi and Kakreta, petha makers used supplied water of Agra Jal Kal. Those who shifted to Kalindi Vihar faced the problem of water quality which eventually affected their businesses (see Table *5: Parameters of quality of supplied water and groundwater*).

  The standards of water quality of supplied Ganga water for Noori Gate (as per discussions with Jal Kal officials) and quality of groundwater in Kalindi Vihar as per a study[7] are as follows:

Table 5: Parameters of quality of supplied water and groundwater

S. no.	Parameter	Value (Noori Gate) Supplied water	Value (Kalindi Vihar) Groundwater
1.	pH	7.22	7.1
2.	Temperature	28	28
3.	Turbidity	0.45 NTU*	3 NTU
4.	Dissolved oxygen (DO)	7.2 mg/l	3 mg/l
5.	Total alkalinity	102 mg/l	400 mg/l
6.	Biochemical oxygen demand (BOD)	Nil	5 mg/l
7.	Chemical oxygen demand (COD)	Nil	19.2 mg/l
8.	Total dissolved solids (TDS)	130 mg/l	2,400 mg/l
9.	Total hardness	48 mg/l	440 mg/l
10.	Calcium ions Ca++	10.4 mg/l	108 mg/l
11.	Magnesium ions Mg++	5.32 mg/l	41.3 mg/l
12.	Chloride CL-	8 mg/l	769.8 mg/l
13.	Sulphate SO_4^{2-}	Nil	432 mg/l
14.	Fluoride F-	Nil	0.83 mg/l
15.	Nitrate NO_3^{2-}	Nil	4.3 mg/l
16.	Iron Fe	Nil	0.1 mg/l

* NTU stands for Nephelometric Turbidity Units

Source: Data as per Jal Kal Vibhag officials; https://www.researchgate.net/publication/281456903_Water_Quality_Status_Near_Kalindi_Vihar_Colony_Tedi_Bagiya_Agra_Uttar_Pradesh_India (last accessed on 26 July 2021)

As per a discussion with the Petha Association, about 15–16 petha makers moved to Kalindi Vihar but due to problems with quality of water only one petha maker is currently operational in Kalindi Vihar while the rest moved to other preferred locations.

Kalindi Vihar, on the outskirts of Agra City, has a population of 10,514 and an area of 0.87 km^2. It has both residential and commercial establishments.

A dedicated colony called Petha Nagari was established here just for petha business but because of the hard water only one petha maker is operational here. Kalindi Vihar was selected after Transport Nagar and Shikandra Rao failed to become Petha Nagari.

Source: (https://geoiq.io/places/Kalindi-Vihar/nwXx1AgI4V).

Abandoned petha-making unit in Kalindi Vihar

Permanently closed petha-making units

Vacant land allocated for establishment of Petha Nagari in Kalindi Vihar

Closed petha-making units in Kalindi Vihar

- There is a significant difference in the availability of labour in Agra city and in Kalindi Vihar due to the dearth of employment opportunities. As most of the petha workers reside nearby Noori Gate, this was a key reason for why a large number of petha makers did not want to relocate their businesses to Kalindi Vihar.[8]

A key recommendation of the Supreme Court was that the administration ensure that all petha makers switch from traditional coal or wood fires to cleaner fuel options such as LPG or CNG. This met with strong resistance from petha makers as they believed that LPG is far more expensive than coal or wood and anticipated that it could substantially increase the cost of producing petha and consequently its selling price as well. The Association of Petha Makers demanded government subsidy in the price of the LPG if the directives were to be implemented. As a result, very few petha makers agreed to shift their business to Kalindi Vihar. Those who had shifted to Kalindi Vihar either shut down their businesses or relocated to other suitable locations or nearby towns such as Hathras, Shikandra Rao and Aligarh.

Chronology of regulatory measures for petha business

- In 1996, the Supreme Court of India banned the use of coal in the Taj Trapezium Zone (TTZ) and directed the Uttar Pradesh Pollution Control Board (UPPCB) and other concerned authorities to reduce the pollution level by shifting coal-based industries (including petha) to the outskirts of the town.[9]

- In 1999, the TTZ Authority announced coverage of an area of 10,400 km^2 to guard the Taj Mahal. TTZ was formed in response to a PIL filed by public interest attorney Mahesh Chandra[10] seeking measures to protect the Taj Mahal from environmental threats. Industries located in the TTZ were mandated to switch from coal or coke to natural gas, and to relocate outside the TTZ or shut down.[11]

- In 2003, industries in the TTZ were ordered to either shift to a gas-based technology or move their units to somewhere identified by the local government. The local government also developed a 'Petha Nagari' in Kalindi Vihar and land was allotted to petha makers. Due to poor planning, however, petha makers unable to shift to Kalindi Vihar.

- In 2013, the Agra Administration and the Uttar Pradesh Pollution Control Board (UPPCB) banned the entry of coal trucks into the Agra city. The petha makers were forced to either switch to low-pollution emitting fuels or to shift to a new location. This affected the whole petha business and many businesses were shut down. Many petha workers also migrated to other locations.[12]

Key findings

Location and concentration of petha makers in Agra

The study was conducted across different petha-making locations in three zones of Agra—Chhatta, Lohamandi and Tajganj. No petha makers were found to be operating in Hariparvat zone because it is the prime locality of Agra city and most of the administrative offices come under Hariparvat zone.

Historically, Noori Gate was the key location for petha making; around 70 petha makers are currently operational there. This number was around 150–200 pre-Covid but due to the pandemic as well as regulatory measures many petha makers have either shifted to other locations or shut down.

Petha waste generation in Agra

About 130 petha-making units are currently located in different parts of Agra. To study the process of petha making, current management practices and disposal of waste generated from petha making and to estimate the quantity of waste, 30 petha makers in eight locations under three administrative zones were covered. During the process, attempts were made to estimate the proportional generation of petha waste in the process of making petha so that going forward the same estimate could be applied to the current volume of petha waste to be managed by the Agra Nagar Nigam (see *Table 6: Estimation of generation of petha waste from raw petha per day*).

Table 6: Estimation of generation of petha waste from raw petha per day

S. no.	Description	Approx. quantity (in tonnes)
1.	Raw petha procured and used per day	44.65
2.	Estimated final product made as petha sweet from the raw petha per day	26.85 (60% of total used raw petha)
3.	Estimated petha waste generated per day	17.8 (40% of total used raw petha)

Source: CSE 2021

Therefore about 0.4 kg of petha waste is generated for every 1 kg raw petha used to make petha.

Petha makers said, in a discussion, that they procured raw petha a day before it was to be used, usually in the evenings if they were located near petha agents. If they live, for example, far from Noori Gate, petha was bought three or four days in advance. If petha was made in Kalindi Vihar, raw petha was procured in advance and this affected the price of petha sweet.

The retail price of raw petha is Rs 15–20 per kg while wholesale price of raw petha is Rs 8–12 per kg. The price is petha sweet is affected by where raw petha is procured from—Bareilly, Etah, Etawa and Meerut in Uttar Pradesh as well as Bangalore and Mangalore in Karnataka are centres for raw petha.

Zone-wise distribution of petha waste generation

Chhatta Zone: There are 28 wards in Chhatta Zone. About 90 petha-making units operate here and use around 28.65 tonnes per day of raw petha. This produces around 17.3 tonnes of petha sweet per day. Around 11.4 tonnes of petha waste is generated every day in the process of making petha

Table 7: Location of petha makers in Chhatta Zone

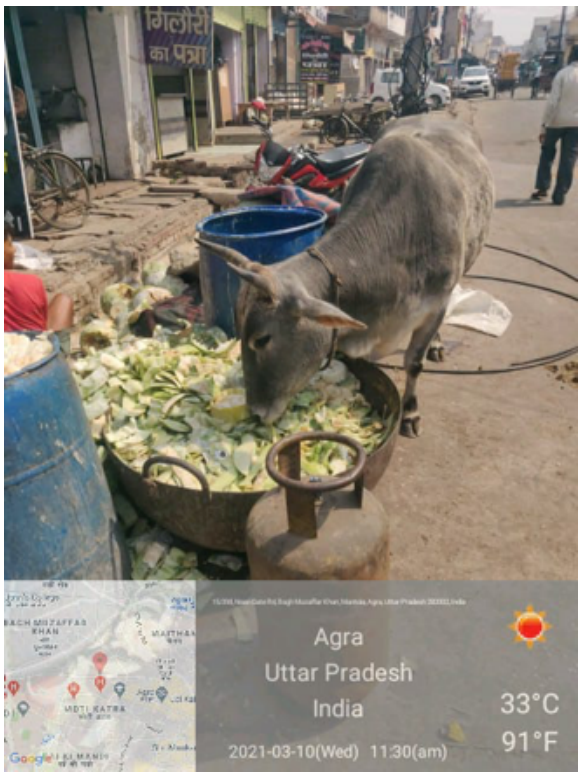
S. no.	Location and ward number	Approximate number of petha-making units
1.	Noori Darwaja (68)	70
2.	Sita Nagar (50)	5
3.	Kalindi Vihar (28)	1
4.	Raja Mandi (84)	14
	Total petha-makers	90

Source: CSE 2021

Noori Gate, Sita Nagar, Raja Mandi and Kalindi Vihar are prime locations in Chhatta Zone. Noori Gate is the oldest habitat and making hub for petha sweet, where large halls are used for making petha.

As stated earlier, Kalindi Vihar was selected for petha makers but only a few moved there. Sita Nagar is residential colony. Petha is made in large halls here.

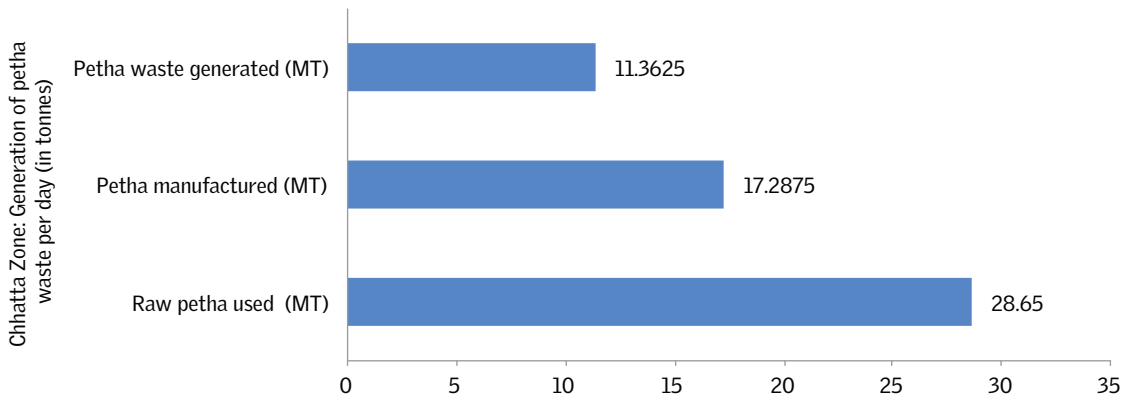
It was observed that as petha making is exhausting work, workers were not wearing personal protective equipment (PPE).



A stray cow eating peels from petha waste

Petha workers making petha in Noori Gate

Figure 2: Petha waste generation in Chhatta Zone



Source: CSE 2021

Lohamandi Zone: There are 25 wards in Lohamandi Zone that use around 11.5 tonnes of raw petha per day, produce around 6.75 tonnes of petha sweet per day and generate around 4.75 tonnes of petha waste every day.

Table 8: Petha makers locations in Lohamandi Zone

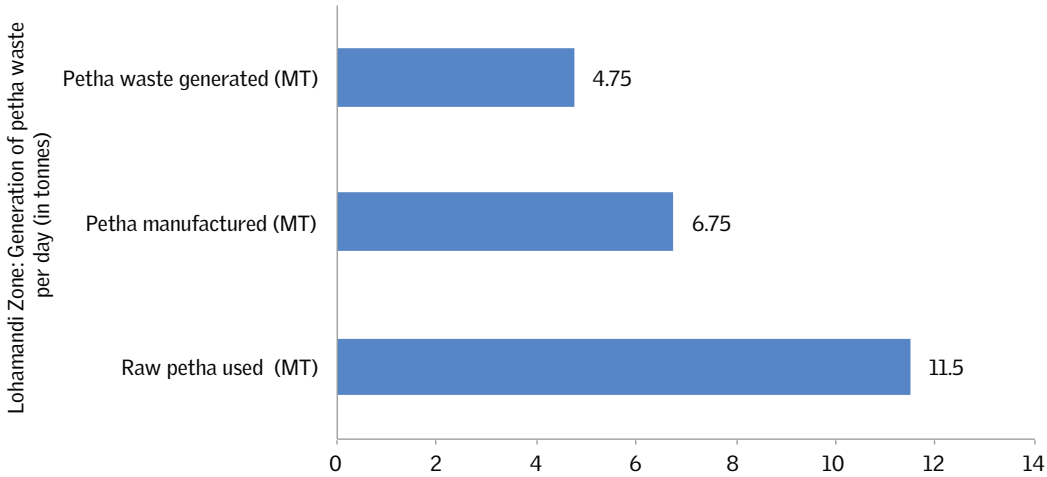
S. no.	Location and ward number	Approximate number of petha-making units
1.	Tedi Para (62)	20
2.	Maharshinagar (96)	5
	Total petha-makers	25

Source: CSE 2021

Tedipara, K.K. Nagar and Kakreta are locations for petha makers in Lohamandi. Most of the petha makers in Lohamandi Zone are in Tedipara. K.K. Nagar and Kakreta are residential colonies where petha makers make petha in halls with good ventilation. In Kakreta, it was seen that a few petha makers disposed of their petha waste in open drains.

Petha waste is disposed of in an open channel near Kakreta

Figure 3: Generation of petha waste in Lohamandi Zone



Source: CSE 2021

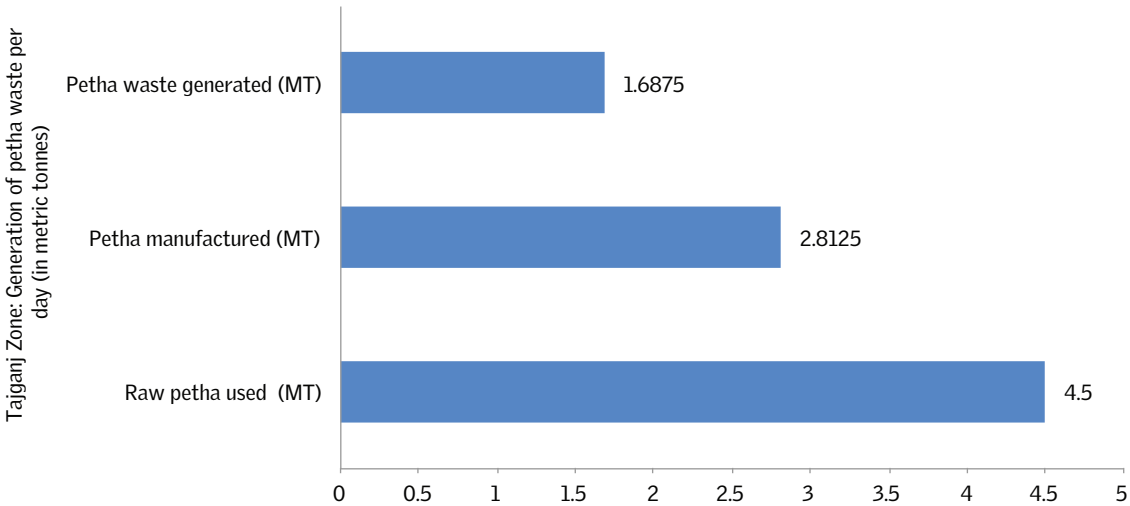
Tajganj Zone: There are 23 wards in Tajganj Zone, where about 15 petha makers currently operate units that use around 4.5 tonnes of raw petha to make petha sweet. Around 2.8 tonnes of petha is manufactured in Tajganj Zone and around 1.7 tonnes of petha waste is generated per day.

Table 9: Petha makers locations in Tajganj Zone

S. no.	Locations and ward number	Approximate number of petha-making units
1.	Ukharra (57)	10
2.	Madhu Nagar (70)	5
	Total petha-makers	15

Source: CSE 2021

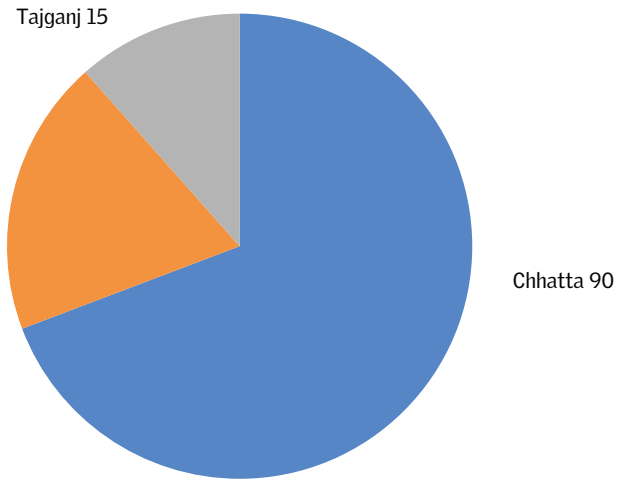
Figure 4: Petha waste generation in Tajganj Zone



Source: CSE 2021

The following analysis examines the distribution of petha makers in Chhatta, Lohamandi and Tajganj Zone, their consumption and production scale and contribution to waste generation.

Figure 5: Zone-wise distribution of petha makers

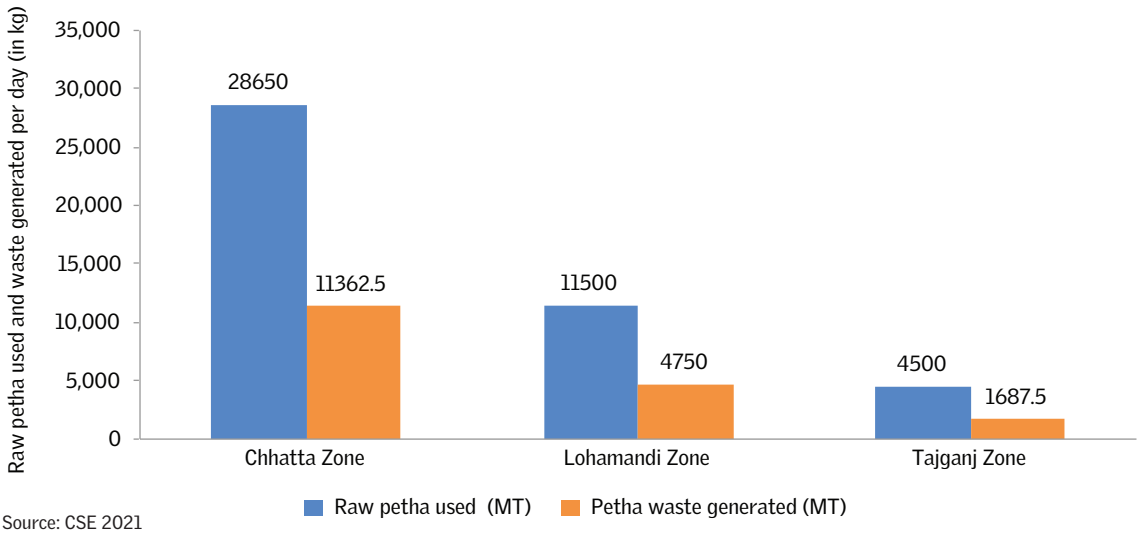


Source: CSE 2021

Lime disposed of on a road in Madhu Nagar, Tajganj, Agra

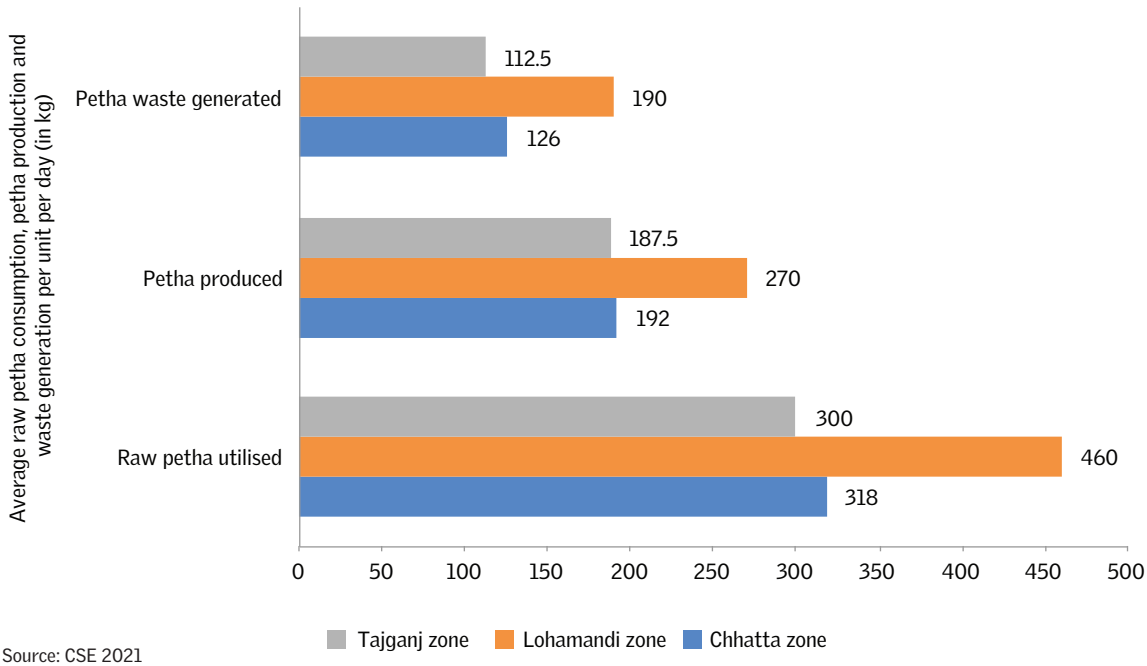
The major fraction of petha manufacturing lies in Chhatta Zone (69 per cent), followed by 19 per cent in Lohamandi Zone, and 12 per cent in Tajganj Zone (see *Figure 7: Average raw petha consumption, production and waste generation per unit per day*).

Figure 6: Zone-wise raw petha used and waste generated per day



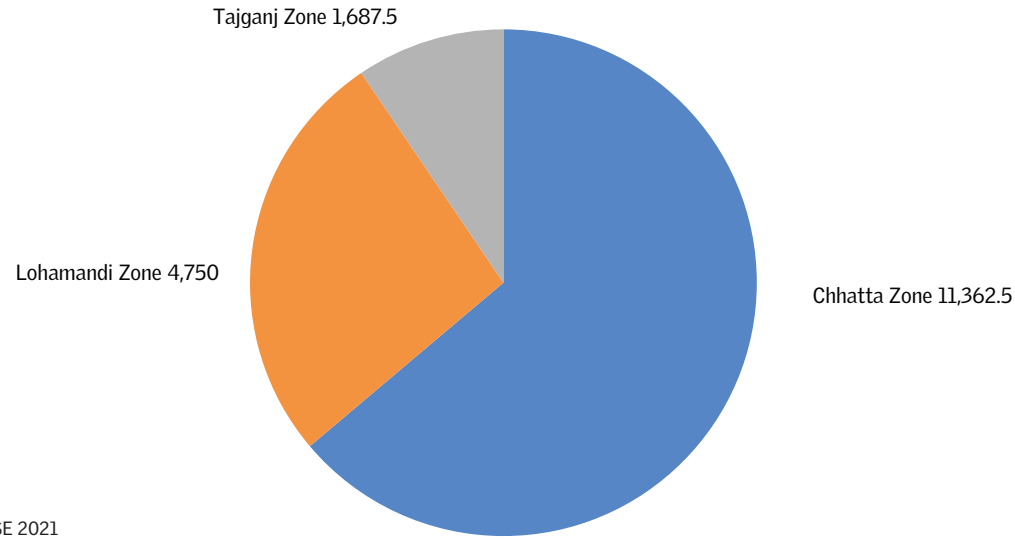
Source: CSE 2021

Figure 7: Average raw petha consumption, production and waste generation per unit per day (in kg)



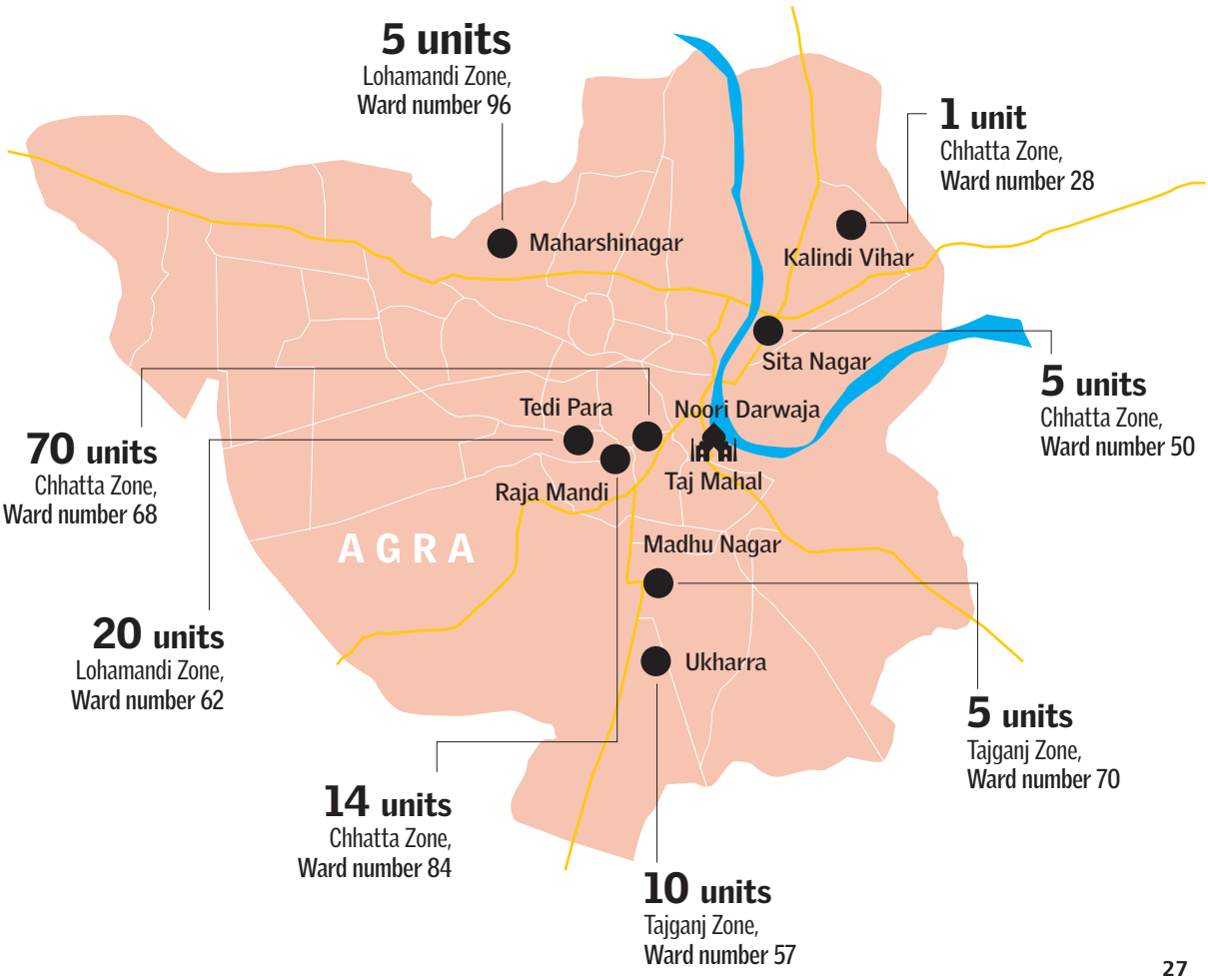
Source: CSE 2021

Figure 8: Zonal contribution to petha waste generation



Source: CSE 2021

Map 1: Petha manufacturing locations in Agra city



The petha value chain

In order to analyse the key determinants for petha production and petha waste generation, the business model that governs the entire value chain must be understood. Petha sweet is sold locally as well as exported to states such as in Delhi, Haryana and Rajasthan.

This study found that there were basically two types of petha makers:

(a) Only petha makers—These are petha businesses that make petha on the basis of orders received and do not have sales outlets of their own. Fifty-nine per cent of the total petha makers were found to belong to this category, accounting for 15.84 tonnes per day of total petha production in Agra city. These makers manufacture petha on the basis of daily orders received broadly from (i) small shops and petha stalls, (ii) orders from marriages and other social gatherings, (iii) bulk orders from institutions, offices, event managers, and (iv) orders placed by the petha exporters.

The Covid-19 pandemic has adversely impacted the petha business, and many petha making establishments have shut down (see *Table 11: Average total business*).

Table 10: Average total order placed

Year	Average total order placed (kg) per day	Small shops or stalls (%)	Marriage or social gatherings (%)	Institutions, offices, event managers (%)	Exporters (%)
2018	106,000	53	13	7	27
2019	96,140	47	12	8	32
2020	29,500	59	8	5	28

Source: CSE 2021

Table 11: Average total business

Year	Average total business (lakhs) per day	Small shops and stalls (%)	Marriages and social gatherings (%)	Institutions, offices, event managers (%)	Exporters (%)
2018	77.0	51	16	9	24
2019	68.9	46	15	10	29
2020	21.0	58	10	6	26

Source: CSE 2021

(b) Petha makers-cum-sellers—These are bigger brands that have a strong market presence and are known for their quality. Their individual business volume is fairly large and sometime they are a network of brands that have multiple outlets across Agra city and other cities. Given their business volume they have built their own units for making petha and don't rely on the other stream who only produce petha without a

sales outlet. About 41 per cent of the total petha makers in Agra fall into this category, which accounts for 11 tonnes of petha produced per day. The quantum of petha sweet produced at outlets owned by the brands is also determined by the orders received apart from the regular average quantity sold through the shop.

Some of the brands are:

a. Panchhi Petha (eight outlets in Agra)
b. Pracheen Petha (six outlets in Agra)
c. Rajeev Petha (one outlet in Agra)
d. Gopaldas Petha wale (three outlets in Agra)

Petha sweet has a long shelf life of seven to 30 days, depending on the ingredients used. This long shelf life ensures negligible quantities of the final product is wasted.

To summarize, two major factors determine the quantity of petha produced every day:

(a) The regular average demand from local and the export markets, which have been hit by the pandemic to bring it down to an all-time low, and
(b) Variable average bulk order received for events (see *Table 12: Average total petha production*).

Table 12: Average total petha production

Year	Average total petha production (kg)	Average local and export demand		Average variable demands for events (kg)	
		(kg)	%	kg	%
2018	74,000	59,200	80	14,800	20
2019	67,260	57,171	85	10,089	15
2020	20,500	18,450	90	2,050	10

Source: CSE 2021

The quantum of petha production determines the quantum of petha waste on a regular basis. It is therefore critical to understand the petha value chain and what drives the market to figure out the variation to appropriately design a management system to deal with collection, transportation and treatment of petha waste.

Table 13: Average daily petha production daily generation of petha waste (kg)

Year	Average daily petha production (kg)	Average daily generation of petha waste (kg)
2018	90,000	60,000
2019	81,700	54,466
2020	25,000	16,666

Source: CSE 2021

The range of petha waste generation is therefore 7,920–20,460 kg per day (see *Table 14: Total quantity of petha produced and petha waste generated*).

Table 14: Total quantity of petha produced and petha waste generated

Location	Total quantity of petha produced and petha waste generated					
	2018		2019		2020	
	Average petha produced (kg)	Average petha waste generated (kg)	Average petha produced (kg)	Average petha waste generated (kg)	Average petha produced (kg)	Average petha waste generated (kg)
Chhatta Zone	62,100	41,400	56,373	37,582	17,250	11,500
Lohamandi Zone	17,100	11,400	15,523	10,348	4,750	3,166
Tajganj Zone	10,800	7,200	9,804	6,536	3,000	2,000

Source: CSE 2021

Petha waste management: current scenario

Storing of petha waste

Storing large volumes of ash gourd peel, which forms almost 40 per cent of the total petha waste, is a challenge for petha makers. Large metal or plastic vessels are used for storing the waste. The size of the vessel depends on the scale of production. For example, every 100 kg of raw petha produces about 40 kg of petha waste, which is completely organic and biodegradable. Petha waste is usually stored for a couple of hours before it is collected or otherwise disposed of.

During this study, vessels full of ash gourd peel were found on the roadside, with stray cattle feeding from it. Field-level observation suggests that the current practice of storing and placement of petha waste prior to disposal needs substantial improvement.

Collection and transportation

With regard to collection and transportation of the petha waste, various practices were observed:

- About 54 per cent petha makers that were interviewed during the study claimed that their waste—which is basically vegetable peels—is collected by cattle farms Agra city. However, no field-level evidence of the collection mechanism was observed. According to this study, there are about 200 cattle farms around the city that require 40,000–48,000 kg of cattle feed every day (assuming the daily diet of cattle is around 25–30 kgs).[13] Therefore systematic channelization of the petha waste could be a good solution to the problem of petha waste in Agra. Such system would require planned fleet movement designed to factor in the total quantity of petha waste generated every day.

Petha waste kept in big pots for collection by the informal sector

- About 5 per cent of petha makers avail of the service of the informal sector to dispose of petha waste on a regular basis. The informal sector was seen to collect waste from the source and dispose it of in nearby dustbins or dhalaos for which they are paid a fixed amount. Rs 500–1,000 is paid to the informal sector is every month for collection and disposal of petha waste.

- It was also found that petha makers based in Noori Gate—3 per cent of the total number of units in the city—avail of the service from the Agra Municipal Corporation. Auto-tippers collect the petha waste from the source every day for a monthly charge of Rs 1,000–1,500 per month. But a few petha makers claimed that timing of Nagar Nigam did not meet their demand and the informal sector worked for them. As per Noori Gate petha makers, there was also some dispute between Nagar Nigam waste collectors and the informal sector and the petha makers felt bound to the informal sector.

- About 38 per cent of petha makers individually disposed of petha waste in nearby dustbins or dhalaos in one or two trips in their own vehicles.

- About 5 per cent of petha makers observed in Kakreta, Lohamandi Zone, disposed of petha waste in drains. They told us that there was no collection services from the Agra Municipal Corporation and the informal sector.

Petha waste transported by a petha manufacturer to a dhalao ghar

Petha waste being disposed of in an open channel near Kalindi Vihar

Processing and treatment

Despite the significant pollution footprints from petha waste since the 1990s, no dedicated facility has been planned or installed. While the Agra Municipal Corporation has recognized the management of petha waste as a major challenge, field-level arrangements to manage the waste were absent. As a result, petha waste has been dealt with like other municipal solid waste generated within the city. Processing and treatment is currently limited to options exercised by the petha makers, such as sending waste to cattle farms as feed for animals, giving the waste to AMC's collection services for monthly charges, getting rid of the waste through the informal collectors and dumping it erratically in the nearest dhalaos or bins.

In absence of a proper collection, transportation and treatment facilities, the problem has barely been addressed. Petha peel and seeds extracted from petha pulp have a good market if avenues to use them are properly planned and executed. Petha seeds can be sold in local markets at different rates depending on whether they are raw or processed. Wet seeds are sold for about Rs 15 per kg while the dried seeds are sold for as much as Rs 60 per kg.

Disposal

Petha waste collected by the Agra Municipal Corporation's fleet from about 8 per cent of the makers is transported to the Kuberpur dumpsite as a routine practice, along with other streams of municipal solid waste. A potential resource that could be used as farm feed or for composting is disposed of every day.

Use of water

The process of petha making requires extensive use of freshwater. Starting from washing raw petha to making the sugar syrup, the process consumes as much as seven to eight litres of water per kilogram of sweet. Every unit in Agra uses 1,652 litres of water every day to produce 206.5 kg of petha per day on an average. The petha making units currently operating in all the three zones in Agra require 214,460 litres of water every day.

The process of making petha requires 60 per cent of water for cleaning of raw petha and the remaining 40 per cent for various phases of sweet making. During the study, no initiative to reuse such huge volumes of water in any form was observed. The quality of water has been one of the many reasons why many petha makers did not want to relocate to Kalindi Vihar despite direction from the judiciary.

- It was observed that petha makers used calcium carbonate (lime or chuna) for manufacturing of petha sweets generating large amounts of wastewater with lime. This was directly discharged into drains without any treatment, consequently increasing the biochemical oxygen demand (BOD) and chemical oxygen demand in wastewater.

- While cleaning ash gourd with water, small pieces of peel and pulp are washed away along with the wastewater, often into the drains, blocking the drainage channel as observed in Kalindi Vihar, Madhu Nagar and Ukharra.

Health problems

Around 130 petha-making units are currently operational in Agra, which generate approximately 17.8 tonnes of petha waste per day. Due to improper collection, transportation and processing facilities most of this petha waste is dumped or disposed of on open plots and grounds or roads as was observed in K.K. Nagar, Kakreta and Lohamandi areas. The petha waste purifies and emits a foul odour, is an unpleasant sight and attracts flies and mosquitoes, leading to diseases such as cholera, diarrhoea, malaria and dengue.[14]

Petha waste is found dumped in drains

Wastewater disposed of in an open drain in Ukharra, Tajganj

The way forward

Creating a geotagged inventory of petha makers in Agra

To effectively plan for sustainable management of petha waste, it is of paramount importance to create an inventory of petha makers in the city. Currently, no such a database is available with Agra Nagar Nigam (ANN).

To create a geotagged database, Agra Nagar Nigam should use its resources at the zone and the ward levels. It needs to initiate a ward-level survey of petha makers. At the ward level, ward supervisors may be deployed to locate the petha-making units and capture other details. Zonal Sanitary Officers (ZSOs) may compile the data at the zone level before it is submitted to the office of ANN to create a city-level database.

The following template may be used for creating the database:

Name of petha maker	Whether the business is registered with Agra Nagar Nigam	Average daily consumption of raw petha	Average daily generation of petha waste	Location (latitude and longitude)

ANN needs to ensure that all the petha-making units are registered with them and accounted for paying applicable taxes. ANN should also ensure that every petha maker receives a trade licence or gets their licence renewed as they are directly or indirectly engaging in business by selling petha sweet. By geotagging the locations and providing trade licenses to the petha makers, ANN can keep a tab on the changing number of petha-making units in Agra.

Owing to the Covid-19 pandemic, the demand for petha sweet in the local market has fallen substantially and petha business has reduced by as much as 75–80 per cent. The market is, however, expected to gain gradual momentum as and when the situation improves. Therefore, the system of registering petha makers needs to be institutionalized so that any new inclusion in the business is captured immediately. Ward supervisors should inspect their respective wards thoroughly to identify any new petha makers. For petha that are not registered, the same process should be followed. To have a view of all the petha makers in the city, all the geotagged locations can be mapped using an App, so that all the city officials can keep a track of the number of petha makers.

Getting the petha makers registered as bulk waste generators

The Solid Waste Management Monitorable Action Plan released by ANN in 2019 reported that 132 bulk waste generators (BWGs) were given notice in 2018 to manage their waste as per the provision of Solid Waste Management Rules, 2016. Another 1,021 bulk waste generators were supposed to receive notice in 2019.

Neither of the two lists include the petha makers in Agra. According to Solid Waste Management Rules, 2016, establishments producing more than 100 kg of waste on a daily basis shall be considered BWGs and they shall be responsible for in situ treatment of the organic waste.

As revealed during the CSE study, all the petha makers are BWGs as they produce more than 100 kg of organic waste on daily basis. Hence Agra Nagar Nigam should serve them notice to get themselves registered as BWGs. ANN should also hold petha makers responsible for managing their wastes themselves or enter into an agreement with AMC or their authorized concessionaires for collection, transportation, and treatment of petha waste in an environmentally sustainable manner as prescribed in the Solid Waste Management Rules.

Once an inventory of petha makers is developed with existing petha units, new units should be served notice to immediately get themselves registered as bulk waste generators. Once the new units are registered, ANN would be able to enforce the provisions of SWM Rules 2016 and effectively monitor them for on-site management of their waste.

Using petha waste as cattle feed in gaushalas and cattle farms in Agra

During the CSE study, it was learned that many existing cattle farms and gaushalas (shed for the stray cattle) collect petha waste from the premises of the petha makers to use as cattle feed. The study also found that petha waste has adequate nutritional value to be used as a supplementary or direct feed for cattle. Therefore, creating a working mechanism to channelize petha waste to existing cattle farms and gaushalas must be seen as the best approach to manage the petha waste in Agra regularly. ANN needs to explore this as an opportunity and facilitate the process so that petha waste from all petha units is collected regularly by the cattle farms and gaushalas for use as feed.

Agra has about 300 cattle shed and 24 gaushalas within the city limit. While the gaushalas are meant for sheltering the stray cattle and they are relatively organized, cattle farms in most cases are not legitimate businesses as they are grown on unauthorized land. According to the study, each cattle farm requires about 60 kg of cattle feed every day;

the total requirement of cattle feed of all the cattle farms is therefore close to 18,000 kg or 18 tonne.

The gaushalas on the other hand are much larger in terms of size and number of animals they look after. In Agra, the number of cattle in the gaushalas is 50–1,000, where the average daily requirement of cattle feed is estimated to be 1071.9 kg or 1.07 tonne (each cow can be fed with about 5 kg of petha peels per day). The 24 gaushalas therefore have the potential to consume 25.68 tonne of petha waste every day as compared to the current estimated generation of 17.8 tonne. When cattle farms are also considered, however, consumption of petha waste could go up to 43.68 tonne per day, which is 245 per cent of the current estimated generation.

According to a directive of National Green Tribunal, cattle farms are not allowed to operate within city limits. Therefore, management of petha waste and channelizing it for reuse should only consider gaushalas as potential consumers and a long-term solution. This could be the best possible option to reuse the petha waste and divert it from going to the dumpsite or polluting neighbourhoods or storm-water drains in Agra.

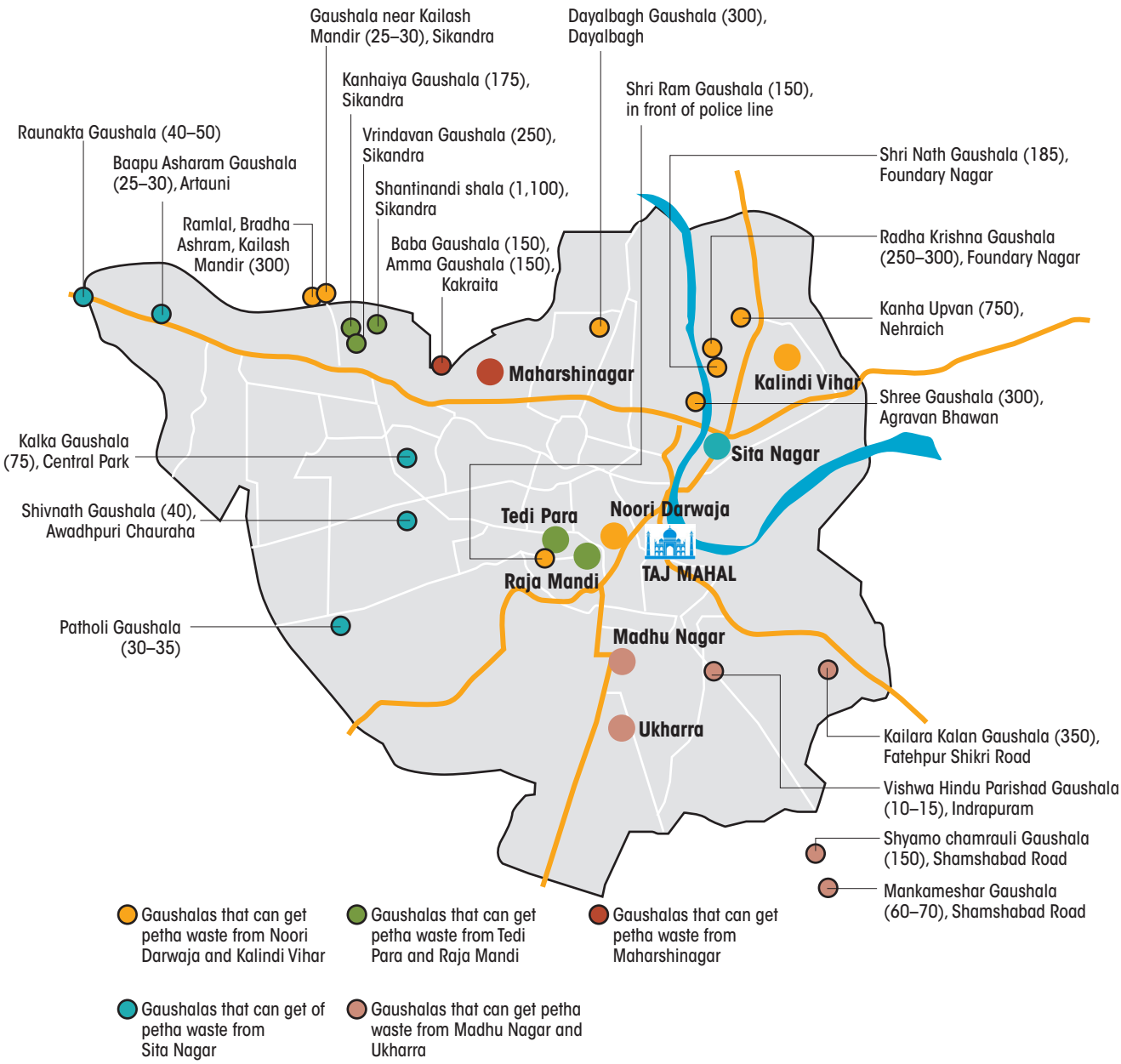
Mapping of gaushalas with petha makers for channelization of petha waste as cattle feed

S. no.	Petha units location	No. of units	Petha waste generated (in kg)	Gaushala location	Intake capacity (in kg)
1.	Noori Gate Kalindi Vihar	70 1	9,727	• Shree Gaushala (300), Agravan Bhawan • Kanha Upvan (750), Nehraich • Radha Krishna Gaushala (250–300), Foundary Nagar • Shri Nath Gaushala (185), Foundary Nagar • Shri Ram Gaushala (150), in front of police line • Dayalbagh Gaushala (300), Dayalbagh • Ramlal, Bradha Ashram, Kailash Mandir (300), Sikandra • Gaushala near Kailash Mandir (25–30), Sikandra	11,575
2.	Tedi Para	20	2,740	• Shantinandi Shala (1,100), Sikandra • Kanhaiya Gaushala (175), Sikandra • Vrindavan Gaushala (250), Sikandra	7,675
3.	Raja Mandi	14	1,918		
4.	Ukharra Madhu Nagar	10 5	2025	• Kailara Kalan Gaushala (350), Fatehpur Sikri Road • Mankameshar Gaushala (60–70), Shamshabad road • Vishwa Hindu Parishad Gaushala (10–15), Indrapuram • Shyamo Chamrauli Gaushala (150) Shamshabad Road	2,925
5.	Sita Nagar	5	685	• Shivnath Gaushala (40), Awadhpuri Chauraha • Baapu Asharam Gaushala (25–30), Artauni. • Raunakta Gaushala (40–50) • Patholi Gaushala (30–35) • Kalka Gaushala (75), Central Park	1,150
7.	Maharshinagar	5	685	• Baba Gaushala (150) • Amma Gaushala (150)	1,500

*Average petha waste generation = 137 kg per unit
* Estimated cattle feed required for each animal is 5 kg of petha waste per day

ANN should facilitate a dialogue between the petha makers, cattle farms and gaushalas to create a system of collection and transportation by tagging the petha makers with the respective gaushalas within a catchment area. ANN may also facilitate signing a formal agreement between petha makers, cattle farms and gaushalas. Dedicated vehicles/tractors need to be assigned zone-wise to collect and transport the agreed quantities of petha waste from the source to cattle farms every day. The cost of transportation can be shared by both petha makers and farms at a rate that is mutually agreed upon.

MAP: PROPOSED SUPPLY OF PETHA WASTE TO GAUSHALAS



Processing of petha waste in decentralized waste to a compost facility or waste to bio-methanation plant

Assuming current generation of petha waste in Agra is 17.8 tonne per day, the total consumption of all the gaushalas is estimated to be around 25.68 tonne. If the mechanism of channelizing the petha waste from the makers to the gaushalas cannot work in certain areas, the petha waste could be processed in a decentralized waste to a compost facility. ANN is in the process of setting up a micro-composting-cum-materials recovery facility in Tajganj Zone to process the wet and dry waste generated in the catchment area for the current pilot initiative in the Taj Trapezium Zone. The cost of transportation of the raw petha waste to the decentralized facility should be borne by the petha units as bulk waste generators.

Once the mapping of all the petha units and the gaushalas is completed, ANN should take necessary measures to divert the petha waste to the decentralized facility for treatment and processing. Alternatively, ANN may also explore the possibility of setting up a waste to biomethanation plant on suitable land near operational petha units in either of the three zones where raw petha waste could be processed through anaerobic digestion to produce biogas.

ANN can install the plant themselves or consider inviting interested private companies to set up the plant using CSR funds for co-branding. The end use of the gas produced could be used by the petha makers themselves to make petha sweet. This way the petha makers could easily shift to clean fuel and the current rate of pollution because of using fossil fuel could be substantially reduced.

The total quantum of petha waste has the potential to generate 1,780 m^3 of biogas that could easily substitute 2,120 kg of coal used by the petha makers every day. Therefore petha waste has the potential to be a more environmentally friendly and long-term solution to produce clean fuel. This can help petha makers save a lot of money on buying fossil fuel, without polluting. Petha makers could be motivated to install portable biodigesters within their premises and reuse an average of 0.14 tonne of petha waste for producing biogas which they could use within their factories for making the sweet without incurring the cost of buying coal.

Alternative use of raw petha waste for generation of food products

Raw petha has several health benefits. Once it is utilized for petha making, however, it is considered as waste by petha makers. Petha waste can also be used to make food products like pickles etc.

Agra Nagar Nigam should explore the possibility of using petha waste. It should characterize petha waste and reach out to food experts. They should also approach renowned chefs to prepare useful food products from waste. After getting credible information on the possible reuse of the raw petha waste, ANN can take on board self-help groups (SHGs) and train them about the food products to create a business model. It should attempt to make a pilot to sell these products to explore whether they could be channelized to create a self-sustainable model.

Implementing clean fuel policy for petha makers and others in TTZ

Since the 1990s, several judicial directives have been issued to reduce pollution sources in the Taj Trapezium Zone. The settlements of petha makers were identified as one of the potential sources of pollution and the administration was directed to relocate the petha units from Agra and ensure that they were using clean fuels in place of coal, which was traditionally used.

For decades, the idea of relocating the petha business from Agra to Kalindi Vihar did not work because of various reasons, including massive protests from the petha makers. ANN should therefore come up with specific policy measures for businesses that were using coal as primary fuel including all petha-making units. This approach would be one of the ways to save and help petha businesses to flourish once the market gains momentum after the global pandemic situation improves. The clean fuel policy for the petha makers should mandate the reuse of petha waste for biomethanation so that all petha-making units use their waste to generate fuel for their consumption. Units unable to comply with the policy must switch to LPG as an alternative.

Waste management and disposal policy for the bulk waste generators: Every petha making unit in Agra generates about 0.13 tonne of raw petha waste every day and should therefore be considered as bulk waste generators as defined in the Solid Waste Management Rules 2016. Considering the potential of reusing the petha waste for composting, biomethanation, or secondary food products, ANN should explore getting on board a concessionaire exclusively for collecting only petha waste from all the units and treat them as per the rules. ANN should also finalize a tariff for petha units to pay to the concessionaire for collection, transportation and treatment of petha waste to make it a financially self-sustained model. ANN should agree to an environmentally sustainable and socially acceptable proposition with the concessionaire to ensure that the collected petha waste is treated according to its merit.

Relocation policy: In September 2012, Agra Municipal Corporation ordered all petha makers to shift to Kalindi Vihar, which was around 11 km from Noori Gate, but

only a few petha makers agreed to move. The reason why most of the petha makers did not relocate to Kalindi Vihar is because of the unavailability of basic amenities in the new location.

Agra Nagar Nigam had planned to establish Kalindi Vihar as Petha Nagiri, but it did not work. To relocate petha makers to the designated area at Kalindi Vihar, AMC must ensure the availability of basic amenities like water supply, electricity connection, and waste collection and treatment facilities, etc. In addition, transportation of the finished sweet to the main city area would cost petha-making units more than what they spent while operating within the city limit.

Petha Nagiri must be developed so that does not hinder the business of petha makers but provides all possible support so that businesses grow. ANN must consider incentive schemes to attract petha makers and shift them to Kalindi Vihar. One of the incentive schemes should be to get them some subsidy on bulk purchase of LPG which has been a long-standing demand of the Petha Association. Petha makers would also require additional space if the number of units returns to pre-pandemic numbers.

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Agra's petha sweet has been popular in India since the reign of Mughal emperor Shah Jahan. Made from ash gourd, it contributes substantial quantities of organic waste to the overall solid waste generated in Agra city. Improper management of petha waste is a challenge for the Agra Municipal Corporation.

This report examines the current status and challenges in the management of petha waste in Agra and recommends strategies to overcome the challenges.

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