Ethnobotanical survey and preliminary phytochemical screening of Posa kumura: an uncharted ethnic food of Assam

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Research

Abstract

Background: India is a land of diverse ethnicity with plethora of ethnic foods. One of the ethnic foods is Posa kumura (a form prepared from matured fruit of *Benincasa hispida*) which is consumed in Assam. However, being not so popular, till date there is no written document to provide an evidence of its origin.

Methods: The present ethnobotanical study consists of both online (Google form) and offline (field visits and interviews) survey with 918 informers of the state having different gender, age groups and occupation through semi- structured questionnaires along with the preliminary phytochemical analysis.

Results: The findings revealed that of 918 respondents (559 male, 358 female and 01 transgender) from 35 districts of Assam, 372 consumes Posa kumura in various forms. Of the 372 people, 75.81% opined that the matured *Benincasa hispida* (Thunb.) Cogn. is placed in shade for varying periods of time for conversion to Posa kumura. Though the production process reported is similar, it is different in terms of how people intend to consume. Frying of Posa kumura (49%) was the most favoured mode of consumption followed by curry (27%), dry (6%) and *pitha* (6%). The age-old health benefits claimed by the consumer of Posa kumura includes improved digestion, anti-diabetic, promotes weight loss, etc. The preliminary phytochemical analysis revealed the presence of carbohydrates, reducing sugars, alkaloids, flavonoids, amino acids, phytosterols, saponins, coumarins. However, phenolics, tannins, phlobatannins, triterpenoids, lignins, quinones, anthraquinones, resins, fixed oils and fats were absent. Besides, Posa kumura also enhances milk production and helps prevent foot and mouth disease of cows.

Conclusion: Thus, it can be inferred that the functional ingredients of this food lead to improvement in health in a holistic way.

Keywords: Ash gourd; *Benincasa hispida* (Thunb.) Cogn.; Cucurbitaceae; ethnic food; ethnobotany; phytochemical analysis; Posa kumura.

Background

India is a land of diverse ethnicity and thus houses a plethora of ethnic foods. Different forms of foods and beverages are prepared and consumed by the different ethnic communities residing all over India (Charupriya *et al.* 2021). The method of preparing indigenous food products is distinctive and differs from community to community depending on the raw materials available. It is passed down from one generation to another (Jamir & Deb 2021). The seven sisters and one brother states of North East India cater to a large number of indigenous tribes and one such state is Assam. Assam has enormous reserve of ethnic food and beverages having distinct flavours such as *Kahudi* or *Pani tenga* (Goswami *et al.* 2017), *Posa Hukoti* (Ghosh *et al.* 2022), *Kharoli* (Barooah *et al.* 2020), *Sukoti* (Barooah *et al.* 2020), *Sai-mod* (Devi *et al.* 2021), *Jou* (Nath *et al.* 2019), *Apong* (Borah *et al.* 2019), *Xaaj* (Kalita *et al.* 2021), *Namsing* (Chowdhury *et al.* 2019) etc.

Another unrecognised fermented vegetable product, popularly known as Posa kumura literally meaning 'rotten' in Assamese dialect and 'ash or wax gourd' in English, is consumed traditionally in some regions of the Indian State of Assam due to its palatable flavor. The mature fruit of *Benincasa hispida* (ash/wax gourd) is used to prepare it.

Posa kumura was traditionally consumed throughout the year based on its availability as the matured ash gourd was stored in the household for longer duration. Long-term storage led to biochemical changes that were probably caused by the development of microorganisms, yet the food nonetheless remained edible and had improved taste and aroma. Despite without understanding the idea of the process of science of microbial growth, our ancestors were able to distinguish between what should be consumed (fermented) and what should not be consumed (putrid)? (Narzary *et al.* 2021).

Posa kumura is a relatively uncommon culinary item, thus there isn't any written documentation to support its ancestry, not even in the historical chronicles and manuscripts known as *Buranjis*, such '*Asom dekhor Buranji*', '*Ahom Buranji*' and books on Assamese cuisines such as '*Barata Mahor Terota Byonjon*', '*Asomiya Aaharor Juti*', '*Asomor Tholuwa Khaydyor Juti*', '*Rondhonr Nitya Notun Juti*', '*Aita Ma Aru Mur Akholor Pora 'Manxor Juti"* etc.

It has historically been consumed by Kalita caste members inhabiting in the Assam region of India, which now resides in six districts: Bajali, Barpeta, Kamrup metropolitan, Kamrup rural, and Nalbari. Presently, it is consumed by individuals from other castes and religions as well; more likely due to mixing of residents from different backgrounds, regardless of caste and religion.

Benincasa hispida (Thunb.) Cogn. (Family: Cucurbitaceae), popularly known as ash gourd, naturally grows in the wilderness in South-East Asian countries such as India, Sri Lanka, China, Nepal and Indonesia (Singh *et al.* 2002). Apart from being used as vegetable, the fruits of *B. hispida* has a number of documented medicinal properties such as anti-diabetic (Patil *et al.* 2011), anti-convulsant activity (Kumar & Ramu 2004), anorectic activity (Kumar & Vimalavathini 2004), anti-obesity (Kumar & Vimalavathini 2004), analgesic (Hemamalini & Varma 2007), anti-compulsive (Girdhar *et al.* 2010). Scholarly search revealed that though a number of fermented plant-based foods and/or products have been documented, however ash gourd is found rarely as an ingredient. The fruits are also consumed in the different fermented form as ethnic food in some parts of the world and are popular by different names such as *Yan-dang-gua* (Taiwan) (Lan *et al.* 2009), *Rakhiya bari* (Chhattisgarh, ndia) (Tiwari *et al.* 2020), *Kohalache sandge* (Maharashtra, India) (Annapure *et al.* 2020).

The dearth of literature on Posa kumura has inspired us to work on this undocumented ethnic food item. Therefore, an effort has been made in this article to chronicle the current method of producing Posa kumura from mature Kumura (*B. hispida*), based on surveys as well as the consumption pattern. The early phytochemical and pharmacognostic investigation of Posa kumura has also been attempted.

Materials and Methods

The study was conducted throughout 2022 in a systematic way, having a structured research questionnaire framework. The research framework was broadly divided into two sections viz. ethnobotanical survey and phytochemical analysis as shown in Figure 1.

Survey area

The study was undertaken in the Indian State of Assam (26.2006° N, 92.9376° E), India. Located in the north-eastern part of India and spanning over an area of 78,438 square km, Assam, is divided into 35 administrative districts (Figure 2).

Data collection

Preparation of bilingual questionnaire for online and offline survey

The questionnaire was divided broadly into 4 sections to avoid order bias as follows:

Demographic information

In this section name, age, gender, location, occupation, household type of the respondent(s) were recorded.

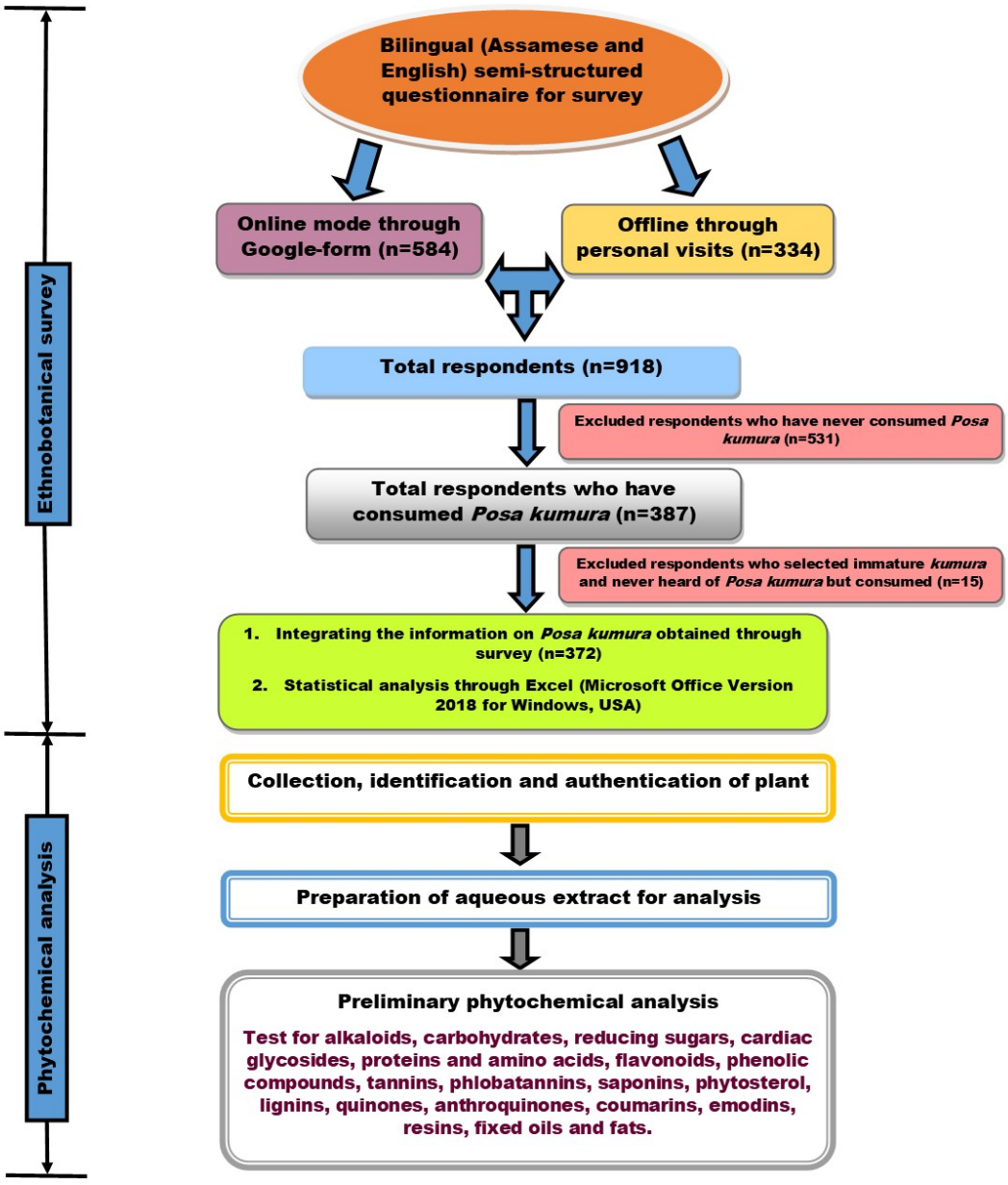

Figure 1. Research framework

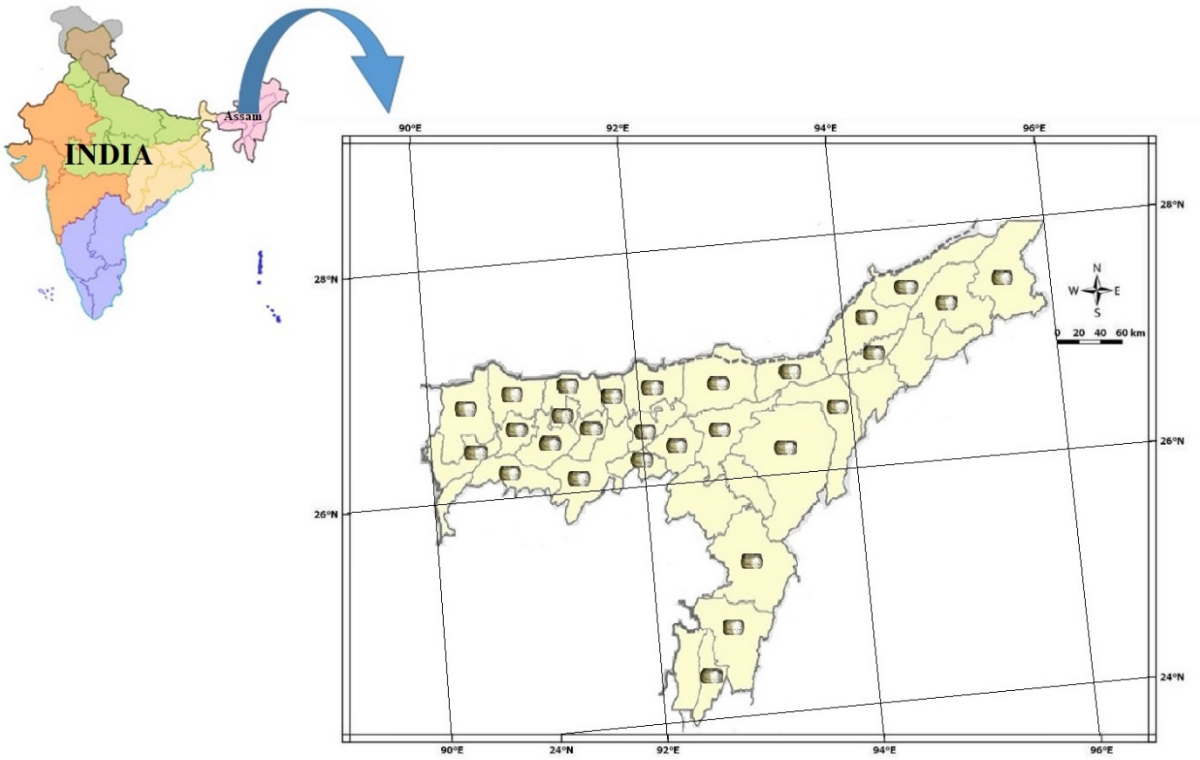

Figure 2. Map of Assam showing districts where people consume Posa kumura as per survey

General information

In this section information on whether the respondent(s) has heard and/ or consumed Posa kumura was recorded.

Preparation process

In this section information related to the type of Kumura (*Benincasa hispida* fruit) used for conversion into Posa kumura along with time, and conditions required were documented.

Other ethnobotanical information

This section dealt with information related to benefits and/or side effects of consumption of Posa kumura, mode and frequency of consumption and its use in festival or treatment of animal related ailments.

Online and offline survey method

Data on all the relevant aspects were collected by means of a semi-structured bilingual questionnaire (Assamese and English) through online (Figure 3) and personal visits (Figure 4). The respondents were asked to provide the information in their own local or regional language based on their personal knowledge and experiences. Ambiguities (if any) were clarified through stereotyped discussions. The information thus obtained were translated into English to plot the graphs and draw inferences. Geotag photographs and videos were also taken to maintain the authenticity of the survey.

Respondents

The survey covered respondents of all ages (over 10 years), regardless of caste, creed, or religion. The respondents for the online survey were first chosen using the convenience sample approach. The people with whom we were in contact were given the URL, and we further requested that they circulate it among their loved ones and friends in a snowball sample fashion. In order to conduct an offline, or in-person, survey, a random sample approach was used to visit specific areas of Assam where the majority of people who had consumed Posa kumura had reported doing so in an online survey. People were questioned during interviews, and the printed questionnaires were completed by the subjects or the researcher. The questionnaires were then signed by the subjects or the researchers, depending on the respondents' preference.

Section 1 of 5

অসমত পচা কোমোৰা প্ৰস্তুতিৰ জাতিগত উপায়

Ethnic way for preparation of Posa Kumura in Assam

অৰ্ধ-গঠিত প্ৰশ্নাবলী, ভাৰতৰ অসমত পচা কোমোৰা প্ৰস্তুতিৰ বাবে উৎপাদন, নৃতাত্ত্বিক আৰু সম্প্ৰদায়ৰ ব্যবহাৰ আৰু জ্ঞান সম্পৰ্কিত তথ্য সংগ্ৰহৰ বাবে ব্যবহৃত হয়।

Semi-structured questionnaire, used for data collection on the production, ethnobotanical and related information in community use and knowledge for Posa Kumura preparation in Assam, India.

Figure 3. Snapshot of the bilingual online questionnaire through Google-form

অসমত পচা কোমোৰা প্ৰস্তুতিৰ জাতিগত উপায়

Ethnic way for preparation of *Posa Kumura* in Assam

অৰ্ধ-গঠিত প্ৰশ্নাবলী, ভাৰতৰ অসমত পচা কোমোৰা প্ৰস্তুতিৰ বাবে উৎপাদন, নৃতাত্ত্বিক আৰু সম্প্ৰদায়ৰ ব্যবহাৰ আৰু জ্ঞান সম্পৰ্কিত তথ্য সংগ্ৰহৰ বাবে ব্যবহৃত হয়।

Semi-structured questionnaire, used for data collection on the production, ethnobotanical and related information in community use and knowledge for *Posa Kumura* preparation in Assam, India.

1. উত্তৰদাতাৰ নাম:/ Name of the respondent : _____
2. বয়স/Age : _____
3. লিঙ্গ/ Gender : _____
4. সাক্ষাৎকাৰৰ স্থান: /Location of interviewee : _____

Figure 4. Snapshot of the bilingual offline questionnaire

Collection, authentication and identification of plant material

The initial identification of the plant material was done in the laboratory by observing the morphological features. The herbarium of the plant material was prepared and deposited at Botanical Survey of India, Central National Herbarium, Howrah in 2021 for authentication and identification. *B. hispida* (Thunb.) Cogn. was authenticated and named for the specimen in a letter number CNH/Tech.II/2021/43a dated November 26, 2021. Posa kumura was gathered in April 2022 from a household in Baghmara, Pathsala, Assam,India for the phytochemical study.

Preparation of extract and preliminary phytochemical analysis

The pulp of Posa kumura was macerated in double distilled water (1:10 *w/v*) using mortar and pestle. The solution was then filtered using Whatman filter paper and stored in an airtight container for further use at 4°C until subjected to qualitative assessment for preliminary phytochemicals. The different standard protocols of Brahma *et al.* (2022), Goyal *et al.* (2010), Shaikh & Patil (2020), Trease & Evans (1978), Mochahary *et al.* (2022) were used to detect the presence or absence of the various phytochemical constituents (Table 1).

Table 1. Preliminary phytochemical analysis of Posa kumura

Sl. No.	Test performed	Procedure	Inference
Detection of alkaloids			
1.	Dragendroff's test	1 mL extract + 1mL Dragendorff's reagent	-
2.	Hager's test	1mL extract + 1mL Hager's reagent	+
3.	Mayer's test	1mL extract + 2 drops of Mayer's reagent	-
4.	Vitali-Morin test	1mL extract + conc. Nitric acid and alcoholic KOH	-
Detection of carbohydrates			
5.	Molisch's test	1mL extract + 3drops of Molisch's reagent + conc. H_2SO_4	+
6.	Test for Starch	1mL extract + 5mL 5% KOH solution	-
7.	Test of Pentose	2mL of conc. HCl + little amount of Phloroglucinol + equal amount of extract + Heated over flame	+
Detection of reducing sugars			
8.	Benedict's test	1mL extract + 1mL Benedict's reagent + Boiled for 2 min.	-
9.	Fehling's test	1mL extract +1mL each of Fehling's solution A & B + boiled in water bath	+
10.	Aqueous NaOH test	Alcoholic extract + dissolved in 1mL of water + few drops of aqueous NaOH solution	-
11.	Conc. H_2SO_4 test	5mL extract + 2mL glacial acetic acid + a drop of 5% $FeCl_3$ + conc. H_2SO_4	-
Detection of cardiac glycosides			
12.	Keller-Killani test	1mL extract + 1.5mL glacial acetic acid + 1 drop of 5% ferric chloride + conc. H_2SO_4 (along the side of test tube)	-
13.	Baljet's test	2mL extract + a drop of Baljet's reagent	+
Detection of proteins and amino acids			
14.	Biuret test	2 mL extract + 1 drop of 2% copper sulphate sol. + 1mL of 95% ethanol + KOH pellets	-
15.	Millon's test	1mL extract + few drops of Millon's reagent	-
16.	Ninhydrin test	1mL extract + 2 drops of Ninhydrin solution + Heat (5min.)	+
Detection of flavonoids			
17.	Alkaline reagent test	i. 1mL extract + 2mL of 2% NaOH solution (+ few drops dil. HCl) ii. 1 mL extract + 10% Ammonium Hydroxide solution	-
18.	Lead acetate test	1mL extract + few drops of 10% lead acetate solution	+
19.	Shinoda's test	Pieces of Mg ribbon + HCl + 1mL extract	-
20.	Shibata's reaction	1mL extract + dissolved in 1-2 mL 50% methanol by heating + metal magnesium + 5 drops of conc. HCl	-
21.	Ferric chloride test	1mL extract +few drops 10% ferric chloride solution	-
22.	Pew's test	1mL extract + metallic zinc + 1mL conc. H_2SO_4	+
23.	Zinc-hydrochloride reduction test	1mL extract + pinch of zinc dust + conc. HCl along the side of test tube	-
24.	Ammonia test	1mL extract + 1mL dil. Ammonia solution + 1mL conc. H_2SO_4	+

Sl. No.	Test performed	Procedure	Inference
Detection of phenolic compound			
25.	Ferric chloride test	1mL extract + 10% $FeCl_3$	-
Detection of tannins			
26.	Braymer's test	1mL extract + 3mL distilled water + 3 drops 10% Ferric chloride solution	-
Detection of phlobatannins			
27.	HCl test	2mL aq. extract + 2mL 1% HCl (boiled)	-
Detection of saponins			
28.	Foam test	2mL extract + 8mL water (vigorously shaken)	+
Detection of phytosterol			
29.	Salkowski's test	1mL extract + 5mL of chloroform + few drops of H_2So_4	+
30.	Libermann-Burchard's test	2mL acetic acid + 2mL chloroform + 1mL extract and cooled + H_2SO_4	-
Detection of terpenoids			
31.	-	2mL chloroform + 5mL extract(evaporated on water bath) + 3mL of conc. H_2So_4 **(boiled in water bath)**	-
Detection of triterpenoids			
32.	Horizon test	2mL trichloro acetic acid + 1mL extract	-
Detection of lignins			
33.	Labat test	1mL extract + gallic acid	-
Detection of quinines			
34.	Alcoholic KOH test	1mL extract + few mL alcoholic potassium hydroxide	-
Detection of anthraquinones			
35.	Borntrager's test	10mL 10% ammonia sol. + few ml filtrate (shaken vigorously for 30 sec.)	-
Detection of coumarins			
36.	NaOH paper test	1g moistened extract is taken in test tube, mouth of test tube is covered with 1N NaOH treated filter paper, heated for few min. in water bath	+
37.	NaOH test	1 mL Plant extract + 1mL 10% NaOH + 1mL Chloroform	-
Detection of resin			
38.	Turbidity test	1mL plant extract dissolved in acetone, poured in distilled water	-
Detection of fixed oil and fats			
39.	Spot/ stain test	Little quantity of plant extract is pressed in between to filter papers	-

'-' indicates absence, '+' indicates presence

Data analysis

After the completion of due time for online survey, the acceptance of response was switched off in the Google form and the final Excel Sheet (Microsoft Office Version 2018 for Windows, Washington, USA) was downloaded. In the same Excel Sheet the data obtained through personal visits were also entered to analyze the responses received from the respondents (Wolgamuth *et al.* 2022). For preliminary phytochemical analysis all the tests were done in triplicate for conformity of the results.

Results and Discussion

Demographic features of the respondents

A total of 584 and 334 respondents provided their responses through online and offline mode respectively covering all the 35 districts of Assam (Figure 5 & 6). Of the total 918 respondents, 559 were males and 358 females and 01 transgender (Figure 7). Based on demography the respondents were categorized into various categories based on their gender, age, and occupation (Figure 7). The percentage of male respondents was higher than females in the current study in both online and offline. The probable reason might be the hesitant nature of the female to face the interview during a personal visit. The respondents involved in the study had various occupations like job (private and government) (36%), business (13%), artists (1%), and housewife (10%) while 33% were students and 07% were unemployed (Figure 7).

Respondents belonging to various districts were also personally visited and interrogated to have a thorough knowledge on the benefits of consuming Posa kumura as they might possess significant traditional knowledge (Figure 5).

It was evident from the survey that people belonging to different caste, religion and ethnic groups such as the Ahom, Baishya, Bodo, Brahmin, Chutia, Hira, Kaibatra, Kalita, Koch, Kuki, Missing, Nath-Jogi, Nepali, Rabha, Rajbongshi, Santhal, Sonowal-Kachari, Sutradhar, Tanti, Adivasi, Muslim etc. consume Posa kumura in various forms. It is also observed that the people who have been consuming since ages are interested in preserving the technique. The knowledge is also flowing quite well from generation to generation

Processing technique

According to the respondents, the typically home-grown Kumura (*B. hispida* fruit) is allowed to mature on the plant itself. Once the fruit is fully ripe and the plant dies off, the fruit is harvested and stored in a shaded area known as *Dhuwa Chang* (literally, "*Dhuwa*" means smoke and "*Chang*" means "Shelf made of bamboo or betel nut tree trunk") or *Chang* (Figure 8) for varying period of time ranging from 6-7 months to over a year at room temperature. From the survey it was clear that there is no fixed time duration for conversion of Kumura to Posa kumura since all the ranges provided in the questionnaire were selected by the respondents through online mode. However, through physical interview with the aged respondents, it was found that the duration was over 10 years in some cases and mostly it was 3-5 years depending upon the quality of matured *B. hispida* fruit. The reason given by the respondents for such a long duration was that, in earlier days no chemicals were used for the production of *B. hispida*. Moreover, the taste has also deteriorated recently because of the overuse of synthetic fertilizers and absence of the local variety of seeds for production.

The distinctive aroma and increased flavor develop with storage as a result of several biochemical and nutritional changes. While picking, however, precautions must be taken as young fruits are more susceptible to shrinkage and mechanical damage and have a shorter shelf life. Only ripe, healthy fruits free of external damage should be preserved. The solid bulk of the fruit degrades as a result of metabolic and nutritional changes, which causes tissue to soften and liquid components to leak out. When tapped with a finger, the thick skin likewise becomes thin. This morphological modification demonstrates that the kumura has been transformed into Posa kumura and is prepared for consumption in a variety of ways. Before cooking, it is peeled with using hand, the pulp is deseeded, and the liquid component is separated by squeezing and finally hanged in a muslin cloth to drain off completely (Figure 9) for all the recipes except *gutir aanja* which is prepared from the seeds of Posa kumura.

Traditional cuisine/ food prepared from Posa kumura

Posa kumura has been used as a delicacy by several communities living in the Lower part of Assam for a very long time, notably in the Bajali, Barpeta, Kamrup metro, Kokrajhar, Kamrup, and Baksa districts (Figure 10). Various preparation methods are employed in accordance with culinary conventions and recipe instructions. According to the respondents, fry (49%) is the most preferred method of consumption, followed by curry (27%), dry (6%), pitha (6%), and other (12%), which includes gutir aanja (seed curry), borha (flitters), bori (nuggets), satni (Indian spread), and others (Figure 11).

Aanja (curry) with small fishes

Fish is washed and cleaned properly. It is marinated with turmeric powder (*Curcuma longa*) and salt and fried in oil. In a separate pan, 1 teaspoon of oil is heated and sliced onion is fried along with the pulp of Posa kumura, turmeric powder, and salt. After frying for some time, water is added and boiled. Fried fish is added and simmered until the taste of the fish is blended with the curry.

Figure 5. Glimpses of the offline survey through personal visits

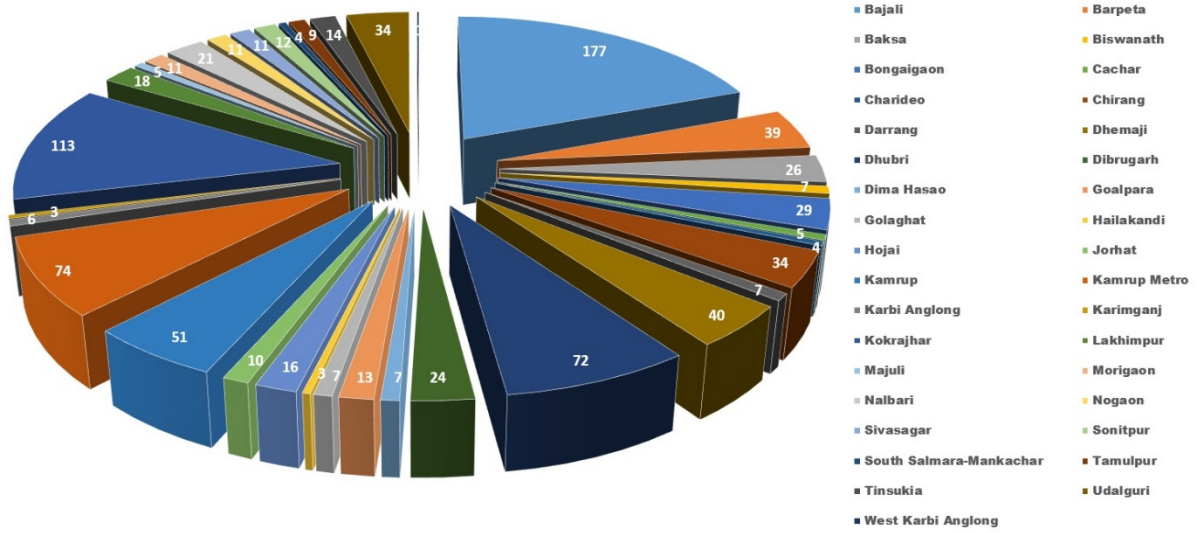

Figure 6. District wise distribution of respondents

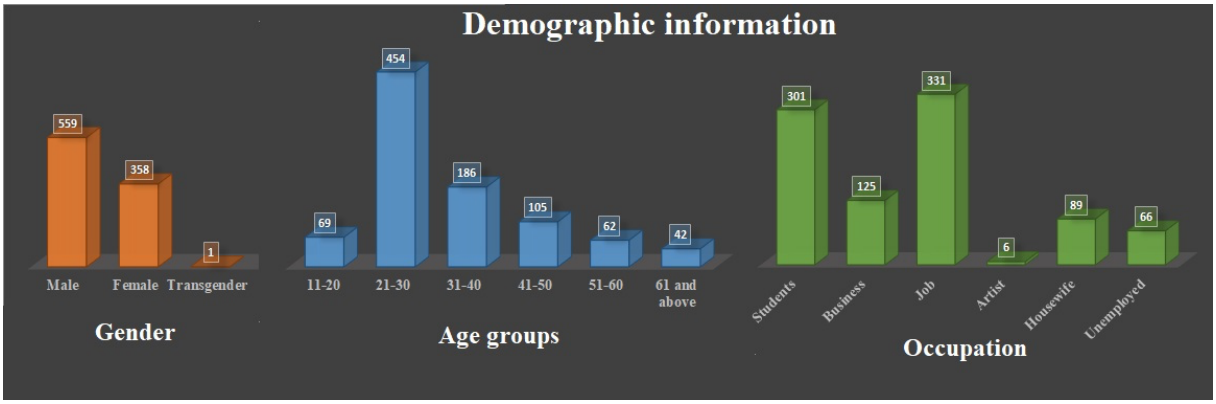

Figure 7. An overview of the demographic information of the respondents

Figure 8. (a) *Dhuwa chang* and (b) *Chang* the place where kumura is kept for conversion to Posa kumura.

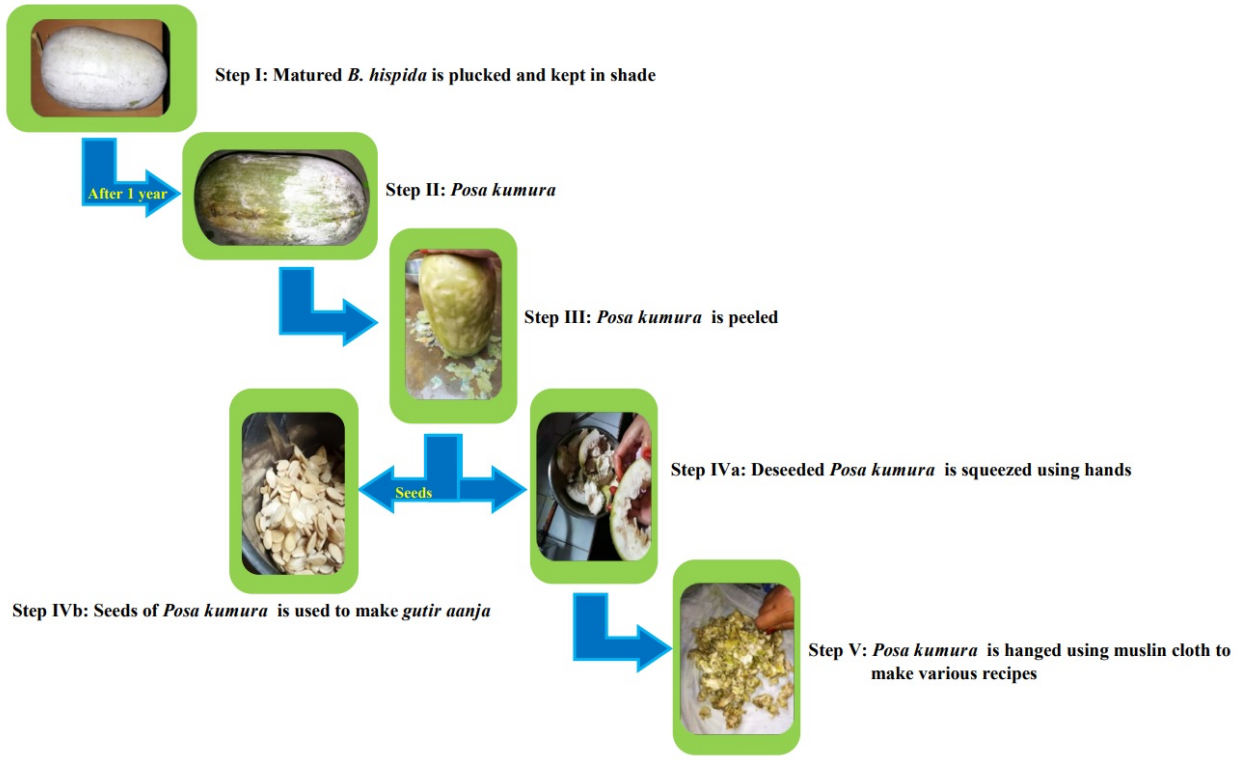

Figure 9. Posa kumura processing technique

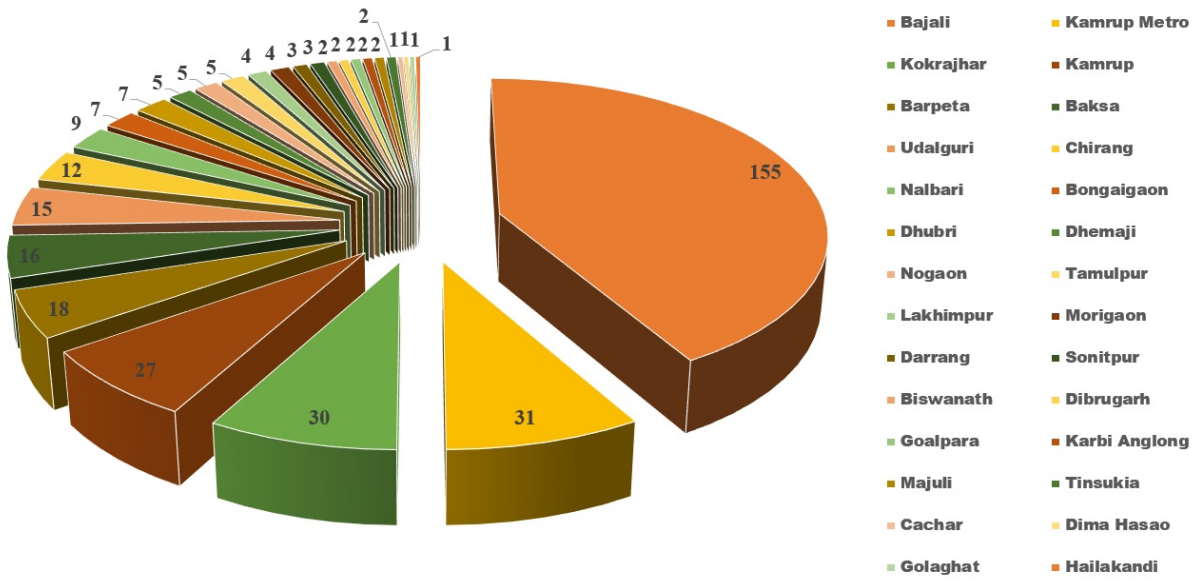

Figure 10. District wise number of respondents who consumed Posa kumura

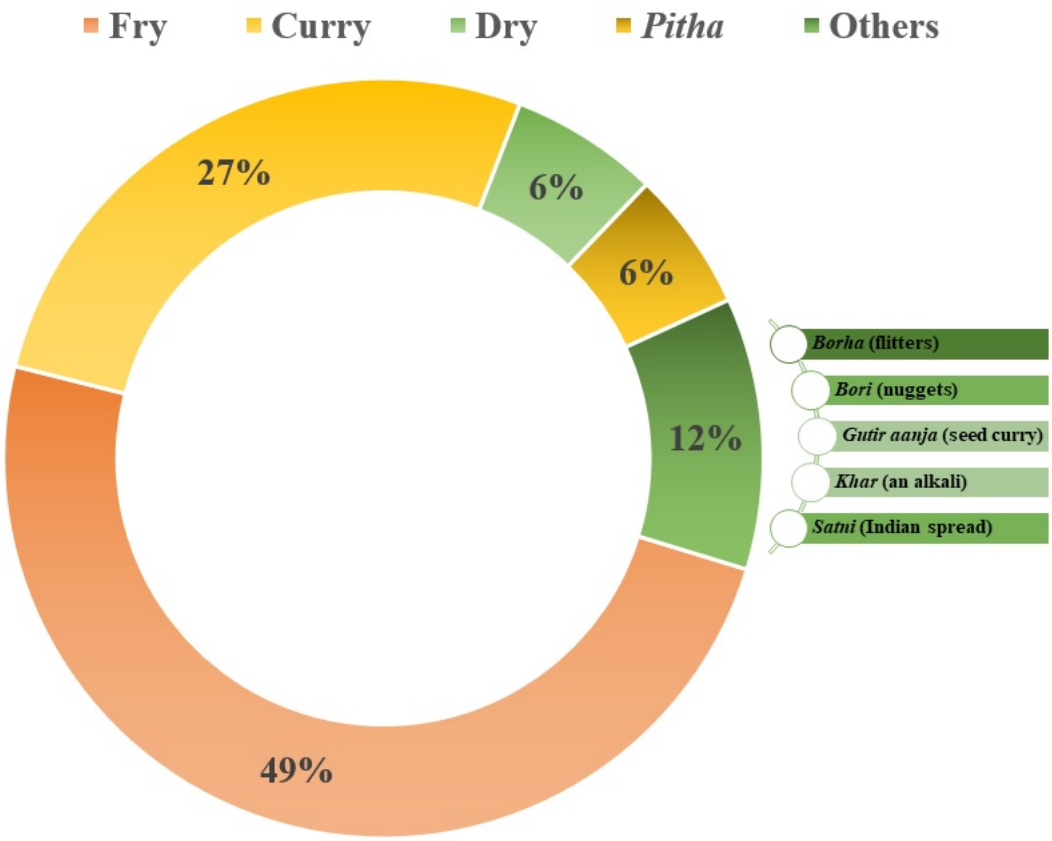

Figure 11. Consumption pattern of Posa kumura

Aanja (curry) with large fishes

Fish pieces were washed and cleaned properly. It is marinated with turmeric powder (*Curcuma longa*) and salt and fried in oil until crispy and brown. In a separate pan, 1 teaspoon of oil is heated and sliced onion is fried along with the pulp of Posa kumura, turmeric powder and salt. After frying for some time, water is added and boiled. Fried fish is added and simmered until the taste of the fish is blended with the curry (Figure 12).

Bhaji (fry)

One teaspoon of oil is heated in a pan and sliced onion is fried along with the pulp of Posa kumura, turmeric powder (*Curcuma longa*), salt and little water. After removing from the flame finely chopped leaves of *mandhaniya* (*Eryngium foetidum*) or *narasingha pat* (*Murraya koenigii*) may be added to enhance flavor (Figure 12).

Pitha (rice cakes)

Posa kumura pulp is mixed with rice (*Oryza sativa*) flour and a pinch of salt and made into equal sized balls. The balls are then flattened to make *pithas* and the cracks at the edges are fixed. The *pithas* are then shallow fried in a non-stick pan with some oil until crispy and golden brown. In another wide bottom pan, water is heated along with jaggery until jaggery melts. The syrup must be of running consistency. The *pithas* are added to the bubbling syrup and cooked for 2-3 minutes. The *pithas* are ready to be served.

Dry

The squeezed Posa kumura is sun dried for use during off season. The dried material can be soaked in water for some time prior to preparation of various food items.

Others

a) *Satni or Chutney* (an Indian spread): The pulp of Posa kumura along with coriander (*Coriandrum sativum*) leaves, 1-2 chillies, a few cloves of garlic and salt as per taste is made into thick paste using a mechanical grinder called *chutney* (Figure 12).

b) *Borha* or *Pakora* (flitters): *Process 1*: To make *borha*, Posa kumura pulp is mixed with thin slices of onion (*Allium cepa*) and chopped chillies (*Capsicum* sp.). These ingredients are then coated with rice flour, salt and made into a dough or *borha*

mixture. Small portions of the mixture is then deep fried in hot mustard oil until crispy and golden brown (fFgure 12).
Process 2: To make *borha*, Posa kumura pulp is mixed with thin slices of onion and chopped chillies. These ingredients are then coated with gram (*Cicer arietinum*) flour (*besan*), refined wheat (*Triticum aestivum*) flour (*maida*), salt and made into a dough or *borha* mixture. Small portions of the mixture is then deep fried in hot mustard oil until crispy and golden brown.
c) *Gutir aanja* (seed curry): The seeds of Posa kumura is made into smooth paste and sieved to remove the seed coats or uncrushed parts. Oil is heated in a fry pan and the fish marinated with turmeric and salt is fried and set aside. In the same oil sliced onion, ginger paste, turmeric powder and salt is fried and then the seed paste is poured in and allowed to cook for some time until the oil begins to separate. Once cooked water is added along with cumin seed powder and bring to boil, a few leaves of *mandhaniya* (*Eryngium foetidum*) or *narasingha pat* (*Murraya koenigii*) along with the fried fish pieces are added and cooked until the taste of the fish is blend with the curry.
d) *Khardi aanja* (Curry with an alkali): One teaspoon of oil is heated in a pan and sliced onion is fried along with the pulp of Posa kumura, turmeric powder, salt and little water. After frying for few minutes, *Khar* (an alkali prepared by burning the skin of Athiyakal/Bhimkol (*Musa balbisiana*) and adding it in water for 1to 2 hour and filtered the liquid by muslin cloth) was added and simmered for 15-20 minutes on low flame.
e) *Bori* or *Badi* (nuggets): *Process 1*: Black gram (*Vigna mungo*) is washed properly and soaked in water for 5-6 hours and then strained to remove excess water. It is then made into coarse paste using a mechanical grinder along with Posa kumura pulp (3:1). A plate is greased with oil and the mixture is made into *bori* using hands and is dried under sun until completely dried and stored in an airtight container (Figure 12).

Figure 12. Some traditional cuisines prepared from Posa kumura. i) *Dry fry*, ii) *Aanja/* fish curry, iii) *Borha/* flitters, vi) *Borha aanja*, v) *Bori/* nuggets and vi) *Satni/* an Indian spread.

Process 2: Corn (*Zea mays*) is powdered coarsely along with *Khudi* or broken rice (*Oryza sativa*) and Posa kumura pulp using a mechanical grinder. Similar to the above process 1, a plate is greased with oil and the mixture is made into *bori* using hands and is dried under sun until completely dried and stored in airtight container.

Ethnopharmacology of Posa kumura

Ethnic foods have a definitive role in improving health and immunity. As per respondents, Posa kumura is considered to possess stomach-soothing properties and helps improve digestion. Besides, it is also considered to be good for people with

diabetes, helps remove kidney stones (anti-urolithiasis), regulates blood pressure (anti-hypertensive), improves skin health and texture, beneficial in urinary tract infection, boosts immune system, helps lose weight, reduces blood cholesterol, increases memory, relieves ear infection, anti-cancerous, antipyretic, improves dental health, increases human fertility and cures mental disturbances etc. but there is no scientific evidence for these traditional claims.

However, Kumarasamy & Radhakrishnan (2022) have already provided evidence of the therapeutic effects of *B. hispida* as an antipyretic, to cure urinary tract infections, and to control mental disorders. The fruits also treat peptic ulcers, the common cold, and constipation, while the seeds assist get rid of tapeworm and other intestinal worms (Pradhan *et al.* 2020).

Identifying characters and phenology of *Benincasa hispida*

It is an annual, monoecious vine. Stem terete, covered with hairs. The leaves are large, rough, alternately arranged attaining 26.43x29.80 cm, 5-9 lobed. Flowers are axillary, solitary, yellowish, unisexual, pentamerous, free petals, diameter 6.83-11.91 cm. Male flowers with three stamens, anther 1.30 cm long, pedicel 12.00-16.80 cm. Female flowers with inferior, ovoid ovary with three stigmas, pedicel 6.20-8.50 cm. Fruits are ovoid-oblong, juicy, melon, green covered with hairs when young, covered with wax layer when matured. Seeds are 1.08x0.61 cm, ovoid, yellowish white.

The phenology of the vegetative phase of *B. hispida* revealed that the germination begins within one week after sowing of the seeds during February to March. The new leaves emerge during March to April, and it continues till September. The plant blooms mainly in the month of May up to August. Fruiting occurs soon after blooming of the female flowers and continues till the August. The plant attain senescence during August and finally the plant dries completely during September-October.

Preliminary phytochemical analysis of Posa kumura

According to the early phytochemical investigation, the substance contained reducing sugars, amino acids, phytosterols, saponins, coumarins, alkaloids, flavonoids, and alkaloids. Phenolics, tannins, phlobatannins, triterpenoids, lignins, quinones, anthraquinones, resins, fixed oils, and fats were not present (Table 1).

The carbohydrate content of Posa kumura was found to be very low when compared with *B. hispida* fresh fruit. The low carbohydrate might help in remission of blood glucose level thereby helping in regulating diabetes (Gram-Kampmann *et al.* 2022). The bioactive compounds such as alkaloids, flavonoids, phytosterols, saponins etc. are effective in inhibiting the formation of calcium oxalate (Sansores-España *et al.* 2022) and thus the presence of such compounds in Posa kumura might be responsible for its anti-urolithiasis activity. Different types of flavonoids decrease the risk of many life-threatening diseases such as diabetes, cancer (Zhao *et al.* 2019), stroke and heart attack (Ullah *et al.* 2022). Flavonoids have also used as antimicrobial (Gupta *et al.* 2022), antiviral (Shahrajabian *et al.* 2022), antiangiogenic (Khater *et al.* 2022), antimalarial, antioxidant (Jain 2022), neuroprotective, antitumor, and anti- proliferative agents (Muema *et al.* 2022). In herbal medicine, cosmetics, phytosterol are important component (Sharma *et al.* 2021). Cardiac glycosides are considered as cancer (Calderón-Montaño *et al.* 2014) and cardiac therapeutics agent (Hou *et al.* 2021, Sharma *et al.* 2021). Coumarins is well known for its anti-hypertensive (Jebir & Mustafa 2022), anti-inflammatory (Padureanu *et al.* 2019), antidiabetic (Li *et al.* 2017), anticoagulant (Sharifi-Rad *et al.* 2020), anticancer (Buga *et al.* 2019), antibacterial (Jebir & Mustafa 2022), antifungal (Chou *et al.* 2007). Its occurrence in Posa kumura might be responsible for its similar activity as per traditional claims.

Effect of Posa kumura in ethnoveterinary practice and animal health

Though, when asked most of the respondents opined that they have no idea on what effect does Posa kumura have on animals when used as animal feed. However, as per one respondent, Posa kumura when used as cow feed enhances milk production. This might be probably due to the presence of various phytochemicals especially flavonoids (Olagaray & Bradford 2019) and saponins (Ebrahim & Negussie 2020). A few respondents suggested that though there is no direct effect of Posa kumura on animal health, but when it is kept hanged in the cowshed, it prevents foot-and-mouth disease (FMD) in cows (Figure 13). This opinion is probably because the perception of health among the ethic population is still entangled with traditional beliefs and practices which may or may not have scientific wisdom.

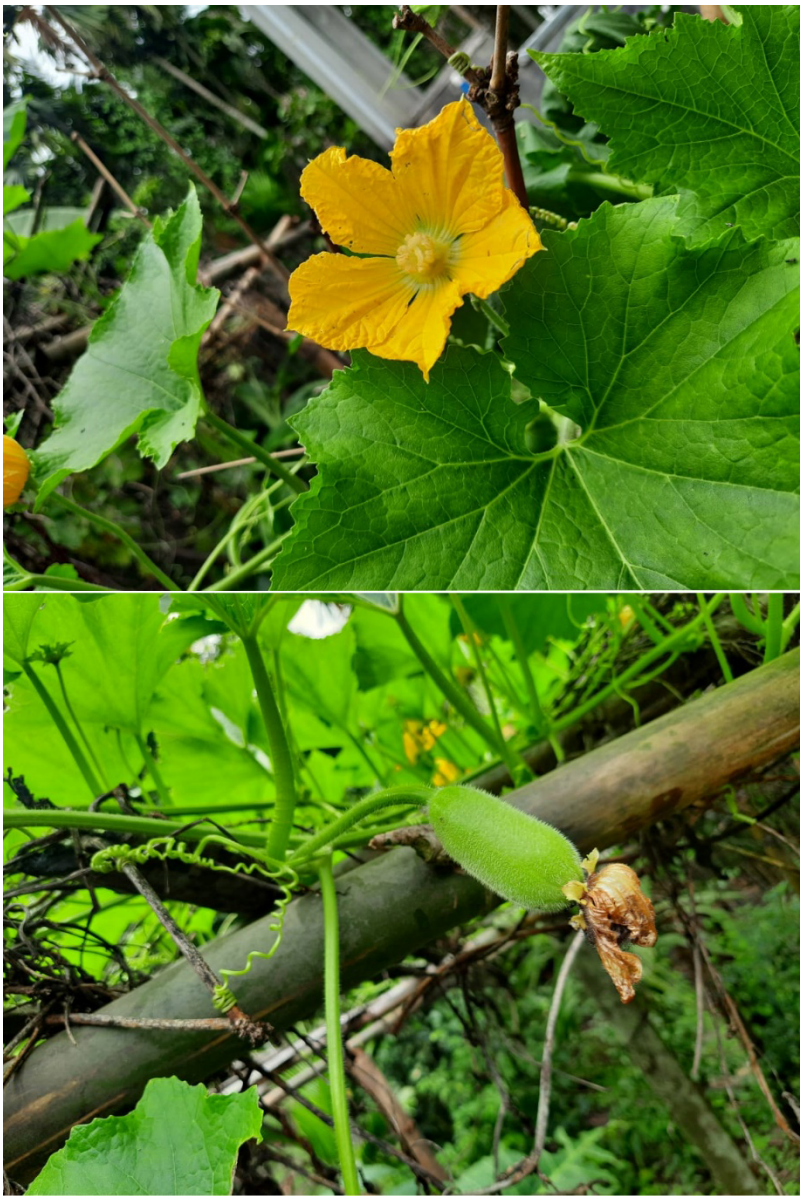

Figure 13. Flowering and fruiting of *B. hispida*

Figure 14. Cowshed with a Posa kumura hanged to prevent FMD in cows

Limitations of the study

Online surveys are becoming more and more popular as a way to collect data because they are quick, simple, and inexpensive. The current study does, however, have some shortcomings that may point to future research prospects. The first drawback is likely due to sample bias; while a portion of the study was conducted online using a Google form, persons living in remote locations and those without access to smartphones were unable to participate. Second, there's a good chance that the survey will experience unidentified response biases. Thirdly, respondents may provide inaccurate information as a result of their ignorance of the topic.

Conclusion

The findings of the blended-mode survey demonstrate that the physical conditions used for the conversion procedure from kumura to Posa kumura, as well as the processing processes used before preparing diverse traditional cuisines, are homogeneous. Even though most food products were produced using similar methods, variations between houses were found in the addition or exclusion of few ingredients. Similar to how ethnic food plays a significant part in boosting immunity and health, Posa kumura contains physiologically active chemicals that may be the cause of its ethnopharmacological advantages for both people and animals. In this study only preliminary phytochemical screening carried out however, characterization of the various phytochemicals need to be done to ascertain the therapeutic potential of Posa kumura.

Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: All participants shown in images gave their prior informed consent to have their photo published.

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Author's contribution: AKG conceived and designed the analysis. AKG, MK, SKM, and DB designed the questionnaire. MK and AKG conducted the personal visit and collected both online and offline ata. All the authors analyzed the data. MK and AKG wrote the first draft of the manuscript. AKG, SKM, and DB critically revised the manuscript. All the authors approved the final version of the manuscript.

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