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Survey and prospecting Jigat production potential of wild species from North East India for agarbathi making

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Abstract
A study was conducted to explore plant species from wild having potential for production of substitute Jigat to mitigate the scarcity of Jigat for agarbathi industry in India. The survey was conducted in NE India and collected plant samples with sticky materials such as bark, leaves, rhizomes, corm, tender shoot, whole plant, flower, fruits, seed etc. The processed and dry samples were grinded into fine particles and sieved through 100 mesh sieve. The powder obtained from each plant species were studied for binding ability to prepare agarbathi as substitute Jigat (SJ). The evaluation of SJs was done by preparing agarbathi using each of the SJs alone and in combination. In the laboratory, SJs were evaluated for stickiness for agarbathi prepared either hand roll or using machine, smoothness of rolled agarbathi, weight of agarbathi, quantity of fragrance absorbed, burning time, odor produced during burning and changes during storage, shelf life etc. The study identified 18 plant species as suitable for using for making agarbathi. Highest number of plant species contributed by Lauraceae. SJs from leaves of 8 and bark of 3 plant species were found best to make agarbathi at standardized ratio 1:3: SJ: filler for hand rolled and 1:4: SJ: filler for machine made agarbathi. The SJ of other 7 plant species need to mix with best SJs to get optimum result.

Keywords: substitute jigat, survey, wild plant, laboratory evaluation

Introduction

Asia Pacific region is the major producer and consumer of the agarbathis. It is a best example of traditional products with indigenous technology at cottage industry level [1, 2]. Mostly, people use to burn Agarbathi for religious purposes and considered as an essential item in every household, temple, etc [3]. Agarbathis are mostly used by rural population in India which was estimated about 61% for domestic use. [4, 5]. Apart from religious use, agarbathi (incense sticks) is now used for a variety of purposes such as to overcome bad smells, repel insects, spirituality, aromatherapy, meditation and simple pleasure [6-9]. Status of India in production of Agarbathi is top of the world; it has manufactured Agarbathi of both domestic and international demand. Among the Indian states Karnataka put in the first place by producing Agarbathi. Agarbathi production by South Indian States comprises 35% of domestic market. While West-India provides 30%, North-India produces 18% and East India accounts for 17% respectively [10]. Apart from domestic utilization, India has supplied more than half of the world's agarbathi requirements. The agarbathis produce in India are mostly exported to USA, the UK, Latin America, Egypt, UAE, and Nigeria. It is reported that India has been being exported agarbathis to nearly 150 countries of the worth about Rs 900 crores per annum. [11].

Agarbathi production units need five different materials: (1) bamboo sticks (for the central core of the Agarbathi); (2) charcoal powder; (3) Jigat powder; (4) Perfume/ Fragrance and (5) Packaging material.

Jigat is one of the most important material and use as binder of filler materials that roll on the bamboo sticks to obtain Agarbathi. Originally, Jigat (adhesive material) is extracted from the glutinous bark of *Persea macrantha* (Syn. *Machilus macrantha*) in Central part of India. Later on the bark of *Litsea glutinosa* (Syn. *Litsea chinensis*) and *Canarium strictum* are emerged as the substitutes of the Jigat [12, 13]. Apart from these, resin from *Ailanthus triphysa*, *Acacia farnesiana*, *Myroxylon toluifera*, *Boswellia serrata*, glues and gum from *Acacia nilotica* etc. are reported to utilize as binding materials by Agarbathi industries [14, 15]. However, increasing demand for Jigat due to the extension of agarbathi industry in India has caused unsystematic felling of Jigat producing trees of the evergreen and semi-evergreen forests of Western Ghats and Northeast India [16]. The Indian agarbathi industry has been suffering from shortage of Jigat powder or such binding agents with adequate burning properties [17]. The literature also available that over a 50 percent of Jigat used by agarbathi industries of India have been importing from Malyasia, Vietnum and Thailand that is Joss powder or its raw materials [18].

Therefore, this work was taken up and identified suitable plant based natural adhesive as substitute of Jigat for incense sticks industry. This work describes technical detail for production of 'Substitute Jigat (SJ)' from different parts of a few wild plant species found in Northeastern region of India.

Materials and Methods

Production of Jigat involves steps such as survey of plant parts of sticky nature i.e. Presence of glue, mucilage or gummy substances, collection or harvesting of such raw materials i.e. plant parts; and processing, drying, grinding, sieving and storage.

Survey of plant species

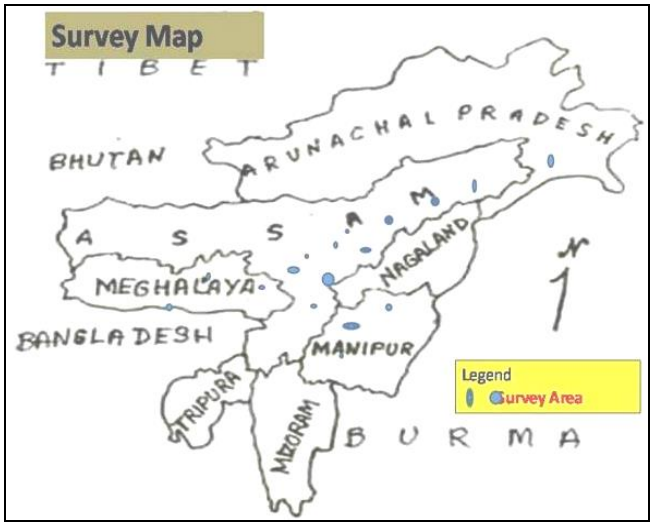

Fig 1: Map showing the survey area for jigat plant of Ne India

Plant species were surveyed from Assam, Arunachal Pradesh, Nagaland, Meghalaya, Manipur and Tripura of North east India during 2014 to 2017 (Fig-1). During survey plant samples such as such as bark, leaves, seeds, flowers, whole plant and tendered shoots were collected or harvested separately for each plant species. Recorded name of plant species (Local/ scientific), date of collection and samples were carried to the laboratory for further study of their efficacy as use for Jigat in laboratory.

Harvesting

Harvesting of plant bark was done from the standing crops by non-destructive method. The vertical narrow stripes were cut in the stem bole or in big branches to extract bark maintaining 60 % a gap in between two. There was made several discontinuous vertical cuts in a stem depending upon the diameter of the plant. Proper care was taken for cut strips so that it should not exceed more than 3 inches in breadth or less depending upon stem dia. Similarly, length of stripe was restricted to 2 fits. Immediately after extraction, the cut area was treated with fungicides. In case of other samples such as leaves, seeds, flowers, whole plant and tendered shoots were harvested from standing plant by gathering small branches @ 30% at a time. In some cases entire branches of a tree was pruned and allowed to grow new branches. Pruning or plucking was done for harvesting of tender plant tips.

Processing

Harvested or collected raw plant samples were promptly unloaded and unpacked upon arrival at the processing unit (i.e. laboratory). Prior to processing, proper care was taken to the plant samples to protect from rain, moisture and any other conditions which may cause deterioration. In laboratory, the plant samples were separated from the branches for flower, fruit & seeds, leaves that were collected in bulk.

Drying

Jigat was prepared form plant samples in dry form. Harvested plant samples were sopped into small sized. These samples were sun dried or oven dried at 60^0C for until it loss almost 80% moisture. The samples were dried to make them suitable to grind into powder and to reduce damage from mould and other microbial infestation. Processing of samples may vary depending upon the type of materials. The plant samples such as bark, corms/rhizome, flower, fruit & seeds, leaves, tender plant or shoot were kept for oven drying at 60ºC or allowed to sun dry. It also took 2-3 days for complete drying. Collected herbs and tendered shoot were sun dried or oven dried. In sunny days the plant materials were dried in sun upon roofing sheet made of tin.

Production of Substitute Jigat (SJ)

After drying of plant materials i.e. leaves, tender plant or bark etc without stock pile were used to prepare the Jigat to avoid absorption of moisture of growth of mould or attack by insects. Completely dried plant materials were grinded to the finest particles using grinder. The grinded plant materials were sieved finely. The sieve used was 100 µm. This powdered form of plant materials is now termed as substitute Jigat (SJ). The Jigat were stored in air tight containers/ ploy coated bags after proper labeling of sample code to avoid damage by absorbing moisture or any fungal and insect attacks.

Evaluation of efficacy of substitute Jigat

Efficacy of the SJs were evaluated for stickiness, smoothness of rolled agarbatti, burning time, odor produced during burning and changes during storage. For that substitute Jigat (SJ) prepared from individual species were tested individually or combinations by mixing two of more Jigat samples. The tested SJ: Filler ratios were 1:3 for hand rolled agarbathi and 1:4 for machine make agarbathi. Charcoal and saw dusts are known as filer materials. The standard filler material ratio was 1:3: sawdust: charcoal. Charcoal was obtained from *Bamboo* spp in the form of bits. The saw dusts used for the experiment were obtained from sawmill. The saw dusts and charcoal bits were dried in oven at 70^0C for 6 hrs. Thereafter grinded and finely sieved through 100 mesh sieve.

These powdered forms of samples or SJs obtained from each plant species alone or in combinations were investigated for their binding efficacy mixing with filler materials in different ratios and combinations by preparing ‘masala’ for making agarbathi. The 8 inches long of bamboo sticks were used to prepare agarbathi. Of which, the length of 6.5 inches was covered by the filler material. A commercial Jigat was used as control for comparing the efficacy of the SJPs obtained from experimental plant species. The Agarbathis prepared out of SJs were thereafter dried in sun for 2 days or kept in hot air oven in laboratory at 60º C for 3 hours for drying the sticks. To determine the dryness of agarbathis several measurement of weight of representative samples were taken at the interval of every 3 hours until they show a constant weight. For this also hot air oven is preferred as naturally dried sticks seem to be fungal affected that prepared in rainy season. The dried incense sticks were treated subsequently with aromatic patchouli oil and kept for an hour or two to dry in shade condition. A schematic representation of the entire process involve in making of Jigat is given in fig. 2.

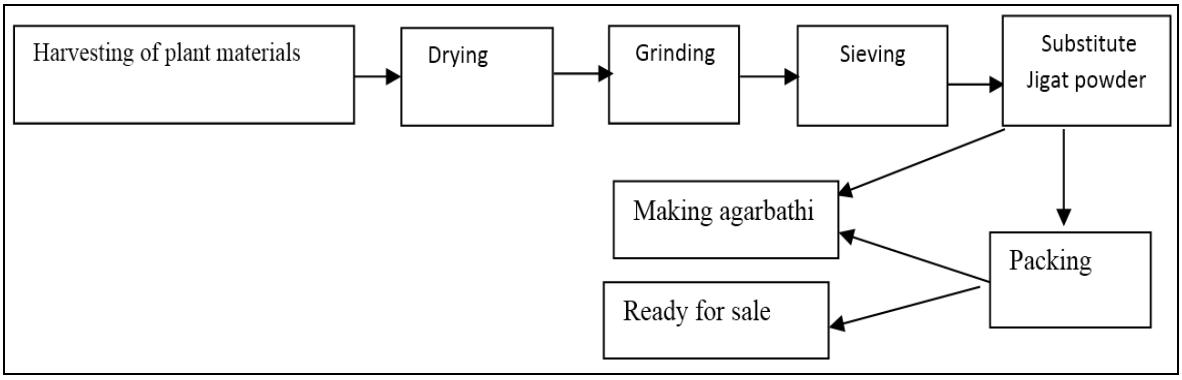

Fig 2: Schematic map of the activities involves in preparation of substitute Jigat.

The endurance adhesiveness or shelf life of made the agarbathi out of SJs were observed during storage. Determination of stickiness and suitability of agarbathi for transportation was done by throwing. During the experiments observations such as stickiness of SJs while prepared agarbathi masala with different ratio to determined optimum ratio, burning ability and continual burning of prepared agarbathi, length of burning time, quantity of aroma/scanted liquid absorbed and odor produces while burning were made. The optimum ratio of substitute Jigat (SJ) obtained from each plant species was determined based on ocular observations such as binding ability of SJ, texture of agarbathi, braking and cracking while drying, throwing and during storage. The burning ability and continual burning of prepared agarbathi, length of burning time were determined by continuous observation during conduct of burning tests. Determination of time taken for burning of agarbathi prepared from these SJs was done using a stopwatch. The evaluation of burning time and continuity in burning was done among the agarbathis made from different substitute Jigat. The length and weight of the agarbathis were taken in to consideration for the experiments. Considering the involvement of economy with fragrance or aromatic liquid absorbed by agarbathi, an experiment was done to record the amount of *Pogostemon cabline* (patchouli) oil as fragrance absorbed in an unit of time and that was compared with control (i.e. agarbathi prepared using commercial Jigat). A sensory evaluation on odor produced at the time of burning before and after application of fragrance was conducted for getting scores for agarbathi produced from each SJPs. The average score of 5 persons were recorded on 1-10 point range table to determine the odor quality of agarbathi due to SJP.

Results and Discussion

Although, samples were collected from more plant species, after preliminary screening of their stickiness the other were discarded. The plant species name, their family, plant parts having sticky materials collected from wild along with their distribution in north eastern states were presented in the Table-1. There were 18 such plant species from wild and they are- *Abroma augsta*, *Actinodaphne angustifolia*, *Actinodaphne obovata*, *Actinodaphne lawsoni*, *Altingia excelsa*, *Bombax cieba*, *Colocasia macorhiza*, *Grewia multiflora*, *Homalomena aromatica*, *Sida cordifolia*, *Sida rhombifolia*, *Urena lobota*, *Impatiens glandulifera*, *Litsea cubaba*, *Litsea sebifera*, *Pouzolgia indica*, *Glychenea sp* and *Pilea rotundinucula*. Of which, 5 plant species belong to Lauraceous**,** 4 from Malvaceae, 2 species from Araceae and Urticaeae each. The plant families Altingiaceae, Bombacaceae, Balsaminaceae, Gleicheniaceae and Tiliaceae contributed one plant species each having sticky materials.

Accordingly, the plant parts used for production of SJPs maximum contribution was obtained from leaves with 8 plant species followed by tender shoot/ plant obtained from 4 plant species, bark from 3 plant species; corm, fruits and whole plant used each from 2 species and flower from 1 plant species (Fig.3). As of now the market price of per kg Jigat/ Joss powder cost in India is Rs. 40-50 + 5 % GST. It is also evaluated that on an average 10 kg fresh leaves or tender plant parts gives 2.5 -3.0 kg dry powder (SJ) and 10 kg fresh bark in turn gives 3.0-4.0 kg of substitute Jigat. This is an encouraging result for the entrepreneurs for setting up of Jigat production unit by cultivating the SJ yielding plants at commercial scale.

Table 1: State wise of distribution of wild plant species suitable for making alternative Jigat in NE India for Agarbathi Industry

Sl No	Name of wild Plant species	Plant parts suitable for making Jigat	Name of the states					
			Assam	Arunachal Pradesh	Nagaland	Meghalaya	Manipur	Tripura
1	*Abroma augsta* L Vern: Gorokhia Korai Fam: Malvaceae	Leaves	+	+	+	+	+	+
2	*Actinodaphne lawsoni* Gamble. Fam: Lauraceae.	Leaves	+	–	–	–	–	–
3	*Actinodaphne angustifolia* (Blume)Nees Vern: Satisoli, Petarichawa. Fam: Lauraceae.	Leaves	+	–	+	+	+	+
4	*Actinodaphne obovata* (Blume) Nees Fam: Lauraceae.	Leaves	+	+	+	+	+	+
5	*Altingia excelsa* Noronha	Leaves	+	+				

	Vern: Jutuli Fam: Altingiaceae	Bark						
6	*Bombax cieba* (L.) Gaertn. (Simolu) Fam: Bombacaceae	Flower	+	+	+	+	+	+
7	*Colocasia macrorhizos* Forster, Adam Vern: Borkasu Fam: Araceae	Corm	+	+	+	+	+	+
8	*Grewia multiflora* Juss. Vern: Kukur suta Fam: Tiliaceae	Tender shoot Leaves Fruit/Seed	+	+	+	+	+	
9	*Homalomena aromatica* (Roxb.) Schott. Vern: Gandh-Kochu Fam: Araceae	Corm	+	+	+	+	+	+
10	*Impatiens glandulifera* Royle Vern: Koria Bijal Fam: Balsaminaceae	Tender plant	+	+	+			
11	*Litsea sebifera* Pers. Vern: Heluka (Neluka) Fam: Lauraceae	Leaves Bark Fruit/Seed	+	+	+	+	+	
12	*Litsea cubaba* (Lour.) Vern: Mejangkori Fam: Lauraceae	Bark	+	-	+	+	+	
13	*Sida cordifolia* L. Vern: Saru Sunborial Fam: Malvaceae	Leaves	+	+			-	
14	*Sida rhombifolia* L Vern: Sonborial Fam: Malvaceae	Whole plant	+	+			+	
15	*Urena lobota* L. Vern: Honborolua Fam: Malvaceae	Leaves	+	+			+	
16	*Pouzolzia indica* (L.) G. Benn. Vern: Borali bukuwa Fam: Urticaeae	Whole plant	+	_				
17	*Pilea rotundinucula* Hayata Vern: Hat bijala Fam: Urticaeae	Tender plant	+	+	-	+	-	-
18	*Glychenea sp* Vern: Bon Dhekia Fam: Gleicheniaceae	Tender plant	+	+	+	+	+	+

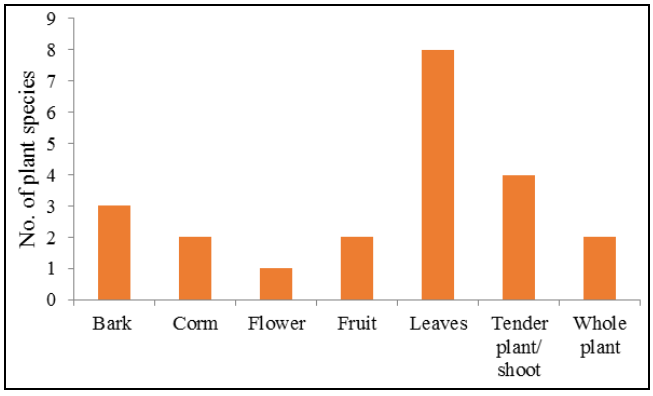

Fig 3: Different plant parts used for production of substitute Jigat from wild plant species of NE India

Efficacy of the SJPs of 18 plant species that were evaluated for stickiness, smoothness of rolled agarbathis, burning time, odor produced during burning and changes during storage is presented in Table 2 & 3. The Jigat prepared from these plant species are having good binding ability (stickiness) and produce textured agarbathi with better burning ability, burning time & odor in comparison to commercial Jigat. Most importantly, agarbathis produced by using SJ are low fragrant absorbent and during storage no moisture absorb, no loss of stickiness and no fungal growth observed. The photographs of a few plant species found suitable for production of substitute Jigat are presented in Fig 4. Best ratio for hand roll agarbathi was 1:3: SJ: filler and machine made agarbathi was 1:4: SJ: Filler was standardized. Among the plant species SJ produced from leaves of *Actinodaphne angustifolia*, *Actinodaphne obovata*, *Litsea sebifera* and *Actinodaphne lawsoni* were best for use as substitute Jigat alone. SJs produced from bark of *Litsea cubeba*, *Litsea sebifera* and *Altingia excelsa* and flower of *Bombax cieba*, corm of *Colocasia macrorhizos*, *Homalomena aromatica* were evaluated as best over control (Commercial Jigat) used to compare the efficacy of SJs. Agarbathi made from different SJ produced from 18 plant species and some activities are presented in Fig 5. SJ produced from *Abroma agusta*, *Grewia multiflora*, *Sida rhombifolia*, *Sida cordifolia*, *Pouzolzia indica*, *Pilea rotundinucula* and *Urena lobata* were evaluated as less suitable with compared to control (i.e. Commercial Jigat). However, they may be used in combination with *Litsea cubeba*, *Litsea sebifera*, *Actinodaphne angustifolia*, *Colocasia macrorhizos*, *Homalomena aromatic* etc to get better result than use alone (Table 2&3). Shelf life of raw

agarbathi made from SJs were found over 1 year and can be stored in moisture free well ventilated room well protected from rain and insect. However after application of fragrance they were tested for shelf life up to 90 days and results were projected in Table 3. The substitute Jigat can be stored over a couple of years if they can be stored in air tight containers. However in ordinary condition packaging in plastic bags after six months fungal growth was seen and SJs become coagulated form instead of its powdered nature. This may happen due to high humidity which may favours fungal growth. Similar research finding of the author about suitability of five cultivated plant species described for producing Jigat at commercial and local use for the agarbathi industry in India [18]. This new finding also could add another 18 plant species from wild habitat as suitable for production substitute Jigat. This work nor only produce SJs but also evaluated suitability for making agarbathi too. As such, Agarbathi industry may be benefited with these encouraging results and will fulfill demand of the scarcity of Jigat. This research could also found out 8 wild plant species from which leaves and 4 plant species tender plant can be utilized for making of Jigat substitute. Earlier Jigat or its substitutes were extracted from bark of the plant species only.

Table 2: Parameter studies before and application of fragrance to the best ratio of substitute Jigat (SJ) for evaluation of suitability

Name	Parameters studied						
	Best ratio (SJ: filler)	Weight/ piece (g)	Uniformity & Texture of Agarbathi	Burning ability	Sensory score (1-10) burning odor		Quantity of Aromatic liquid absorbed (ml/stick)
					Before*	After*	
Commercial Jigat (CJ)	1:3 for hand rolled	1.25	Best & Smooth^{+++}	Uniformly burnt	10	10	0.32
	1:4 for Machine	1.10	Best & Smooth^{+++}	Uniformly burnt	10	10	0. 25
Abroma augsta L	1:3 for hand rolled	1.32	Good & Smooth^{++}	Uniformly burnt	7	7	0.46
	1:4 for Machine	1.19	Best & Smooth^{+++}	Uniformly burnt	7	7	0.40
Actinodaphne angustifolia (Blume) Nees	1:3 for hand rolled	1.1	Best & Smooth^{+++}	Uniformly burnt	10	10	0.39
	1:4 for Machine	0.93	Best & Smooth$^{++ +}$	Uniformly burnt	10	10	0.30
Actinodaphne lawsoni Gamble	1:3 for hand rolled	1.22	Good & Smooth^{+++}	Uniformly burnt	10	10	0.33
	1:4 for Machine	1.05	Good & Smooth$^{++ +}$	Uniformly burnt	10	10	0.27
Actinodaphne obovata (Blume) Nees	1:3 for hand rolled	1.32	Best & Smooth$^{++ +}$	Uniformly burnt	9	9	0.37
	1:4 for Machine	1.04	Best & Smooth^{+++}	Uniformly burnt	9	9	0.30
Altingia excelsa Noronha	1:3 for hand rolled	1.30	Medium&Smooth^{+++}	Uniformly burnt	10	10	0.34
	1:4 for Machine	1.12	Medium&Smooth^{+++}	Uniformly burnt	10	10	0.30
Bombax cieba (L.) Gaertn	1:3 for hand rolled	1.22	Good & Smooth^{++}	Uniformly burnt	9	9	0.38
	1:4 for Machine	1.16	Good & Smooth^{++}	Uniformly burnt	9	9	0.34
Colocasia macrorhiza Forster, Adam	1:3 for hand rolled	1.22	Good & Smooth^{+++}	Uniformly burnt	10	10	0.35
	1:4 for Machine	1.12	Good & Smooth^{+++}	Uniformly burnt	10	10	0.26
Grewia multiflora Juss.	1:3 for hand rolled	1.30	Good & Smooth^{++}	Uniformly burnt	10	10	0.36
	1:4 for Machine	1.16	Good & Smooth^{++}	Uniformly burnt	10	10	0.30
Homalomena aromatica (Roxb.)	1:3 for hand rolled	1. 21	Good & Smooth^{+++}	Uniformly burnt	10	10	0.37
	1:4 for Machine	1.00	Good & Smooth^{+++}	Uniformly burnt	10	10	0.25
Impatiens glandulifera Royle	1:3 for hand rolled	1.40	Good & Smooth^{++}	Uniformly burnt	8	8	0.50
	1:4 for Machine	1.10	Good & Smooth^{++}	Uniformly burnt	8	8	0.36
Litsea sebifera Pers	1:3 for hand rolled	1.30	Good & Smooth^{+++}	Uniformly burnt	10	10	0.33
	1:4 for Machine	1.10	Good & Smooth^{+++}	Uniformly burnt	10	10	0.29
Litsea cubaba (Lour.)	1:3 for hand rolled	1.22	Good & Smooth^{+++}	Uniformly burnt	10	10	0.31

	1:4 for Machine	1.00	Good & Smooth^{+++}	Uniformly burnt	10	10	0.27
Sida cordifolia L.	1:3 for hand rolled	1.21	Medium &Smooth^{++}	Uniformly burnt	8	9	0.34
	1:4 for Machine	1.10	Medium &Smooth^{++}	Uniformly burnt	8	9	0.29
Sida rhombifolia L	1:3 for hand rolled	1.20	Good & Smooth^{++}	Uniformly burnt	8	9	0.39
	1:4 for Machine	1.13	Good & Smooth^{++}	Uniformly burnt	8	9	0.30
Urena lobota L.	1:3 for hand rolled	1.27	Good & Smooth^{+++}	Uniformly burnt	8	9	0.32
	1:4 for Machine	1.10	Good & Smooth^{+++}	Uniformly burnt	8	9	0.27
Pouzolzia indica (L.) G. Benn	1:3 for hand rolled	1.25	Good & Smooth^{++}	Uniformly burnt	8	9	0.35
	1:4 for Machine	1.10	Good & Smooth^{++}	Uniformly burnt	8	9	0.30
Pilea rotundinucula Hayata	1:3 for hand rolled	1.25	Good & Smooth^{++}	Uniformly burnt	8	9	0.40
	1:4 for Machine	1.00	Good & Smooth^{++}	Uniformly burnt	8	9	0.32
Glychenea sp	1:3 for hand rolled	1.20	Good & Smooth^{+++}	Uniformly burnt	9	9	0.39
	1:4 for Machine	1.10	Good & Smooth^{+++}	Uniformly burnt	9	9	0.30
Composite sample							
Actinodaphne angustifolia + *Grewia multiflora*	1:3 for hand rolled	1.10	Best & Smooth^{++}	Uniformly burnt	10	10	0.38
	1:4 for Machine	1.00	Best & Smooth^{+++}	Uniformly burnt	10	10	0.29
Actinodaphne obovata + *Urena lobota*	1:3 for hand rolled	1.20	Best & Smooth^{+++}	Uniformly burnt	10	10	0.36
	1:4 for Machine	1.10	Best & Smooth^{+++}	Uniformly burnt	10	10	0.27
Homalomena aromatica + *Pouzolzia indica*	1:3 for hand rolled	1.24	Best & Smooth^{+++}	Uniformly burnt	10	10	0.30
	1:4 for Machine	1.10	Best & Smooth^{+++}	Uniformly burnt	10	10	0.26
Litsea sebifera + *Sida rhombifolia*	1:3 for hand rolled	1.30	Best & Smooth^{+++}	Uniformly burnt	10	10	0.27
	1:4 for Machine	1.10	Best & Smooth^{+++}	Uniformly burnt	10	10	0.22
Altingia excelsa + *Abroma augsta*	1:3 for hand rolled	1.27	Best & Smooth^{+++}	Uniformly burnt	10	10	0.40
	1:4 for Machine	1.00	Best & Smooth^{+++}	Uniformly burnt	10	10	0.30

*Application of fragrance

Table 3: Evaluation of binding property and suitability to use as substitute Jigat

Name	Observation	Parameters studied							
		Binding Quality	Agarbathi Texture (%)	Burning ability (after drying)	Burning time (Min)	Moisture absorption in storage	Loss of Stickiness in storage	Changes / Microbial growth	Transport Suitability
Commercial Jigat (CJ)	30 days	best	smooth	consistent	60	No	No	No	suitable
	60 days	best	smooth	consistent	58	No	No	No	
	90 days	best	smooth	consistent	52	No	No	No	
Abroma augsta L	30 days	Good	smooth	consistent	47	No	No	No	suitable
	60 days	Good	smooth	consistent	47	No	No	No	
	90 days	iGood	smooth	consistent	52	No	No	No	
Actinodaphne angustifolia (Blume)Nees	30 days	best	smooth	consistent	65	No	No	No	
	60 days	intact	intact	consistent	74	No	No	No	suitable
	90 days	intact	intact	consistent	78	No	No	No	
Actinodaphne lawsoni Gamble	30 days	Good	Smooth	consistent	60	No	No	No	suitable
	60 days	intact	intact	consistent	59	No	No	No	
	90 days	intact	intact	consistent	65	No	No	No	
Actinodaphne obovata (Blume) Nees	30 days	Good	Smooth	consistent	53	No	No	No	suitable
	60 days	intact	intact	consistent	54	No	No	No	

	90 days	intact	intact	consistent	50	No		No	
Altingia excelsa Noronha	30 days	Good	Smooth	consistent	56	No	No	No	Suitable
	60 days	intact	Smooth	consistent	55	No	No	No	
	90 days	intact	Smooth	consistent	57	No	No	No	
Bombax cieba (L.) Gaertn	30 days	Good	Smooth	consistent	55	No	No	No	Suitable
	60 days	Good	Smooth	consistent	55	No	No	No	
	90 days	Good	Smooth	consistent	56	No	No	No	
Colocasia macrorhizos Forster, Adam	30 days	Good	Smooth	consistent	65	No	No	No	Suitable
	60 days	Good	Smooth	consistent	69	No	No	No	
	90 days	Good	Smooth	consistent	65	No	No	No	
Grewia multiflora Juss.	30 days	Good	Smooth	consistent	60	No	No	No	Suitable
	60 days	intact	intact	consistent	60	No	No	No	
	90 days	intact	intact	consistent	62	No	No	No	
Homalomena aromatica (Roxb.)	30 days	Good	Smooth	consistent	66	No	No	No	Suitable
	60 days	Good	Smooth	consistent	65	No	No	No	
	90 days	Good	Smooth	consistent	67	No	No	No	
Impatiens glandulifera Royle	30 days	Good	Smooth	consistent	56	No	No	No	Suitable
	60 days	Good	Smooth	consistent	56	No	No	No	
	90 days	Good	Smooth	consistent	57	No	No	No	
Litsea sebifera Pers	30 days	Good	Smooth	consistent	58	No	No	No	Suitable
	60 days	intact	intact	consistent	55	No	No	No	
	90 days	intact	intact	consistent	50	No	No	No	
Litsea cubaba (Lour.)	30 days	Good	Smooth	consistent	66	No	No	No	Suitable
	60 days	Good	Smooth	consistent	62	No	No	No	
	90 days	Good	Smooth	consistent	63	No	No	No	
Sida cordifolia L.	30 days	Good	Smooth	consistent	46	No	No	No	Suitable
	60 days	Good	Smooth	consistent	46	No	No	No	
	90 days	Good	Smooth	consistent	48	No	No	No	
Sida rhombifolia L	30 days	Good	Smooth	consistent	58	No	No	No	suitable
	60 days	intact	intact	consistent	60	No	No	No	
	90 days	intact	intact	consistent	60	No	No	No	
Urena lobota L.	30 days	Good	Smooth	consistent	46	No	No	No	Suitable
	60 days	intact	Smooth	consistent	46	No	No	No	
	90 days	intact	Smooth	consistent	47	No	No	No	
Pouzolzia indica (L.) G. Benn	30 days	Good	Smooth	consistent	52	No	No	No	Suitable
	60 days	intact	Smooth	consistent	54	No	No	No	
	90 days	intact	Smooth	consistent	54	No	No	No	
Pilea rotundinucula Hayata	30 days	Good	Smooth	consistent	48	No	No	No	Suitable
	60 days	intact	Smooth	consistent	52	No	No	No	
	90 days	intact	Smooth	consistent	52	No	No	No	
Glychenea sp	30 days	Good	Smooth	consistent	50	No	No	No	Suitable
	60 days	intact	Smooth	consistent	50	No	No	No	
	90 days	intact	Smooth	consistent	54	No	No	No	
Composite sample									
Actinodaphne angustifolia + Grewia multiflora	30 days	Good	Smooth	consistent	66	No	No	No	Suitable
	60 days	intact	Smooth	consistent	66	No	No	No	
	90 days	intact	Smooth	consistent	67	No	No	No	
Actinodaphne obovata + Urena lobota	30 days	Good	Smooth	consistent	59	No	No	No	Suitable
	60 days	intact	Smooth	consistent	60	No	No	No	
	90 days	intact	Smooth	consistent	60	No	No	No	
Homalomena aromatica +Pouzolzia indica	30 days	Good	Smooth	consistent	68	No	No	No	Suitable
	60 days	intact	Smooth	consistent	70	No	No	No	
	90 days	intact	Smooth	consistent	70	No	No	No	
Litsea sebifera + Sida rhombifolia	30 days	Good	Smooth	consistent	62	No	No	No	Suitable
	60 days	intact	Smooth	consistent	65	No	No	No	
	90 days	intact	Smooth	consistent	65	No	No	No	
Altingia excelsa + Abroma augsta	30 days	Good	Smooth	consistent	59	No	No	No	Suitable
	60 days	intact	Smooth	consistent	61	No	No	No	
	90 days	intact	Smooth	consistent	60	No	No	No	

Fig 4: A few wild plant species suitable for making Substitute Jigat (SJ) from NE India

Fig 5: The photographs detailing few moments of evaluation of efficacy of SJ: (A) Preparation of agarbathi using SJ: (B) Agarbathi made from 3 different SJ; (C) Agarbathi using SJ of *Actinodaphne lawsoni;* (D) Agarbathi using SJ of *Litsea cubeba*; (E) Agarbathi using SJ of *Litsea sebifera*; (F) Agarbathi using SJ of *Actinodaphne obovata*; (G) Agarbathi using SJ of *Grewia multiflora*;(H) Agarbathi using SJ of *Actinodaphne angustifolia*;(I) Agarbathi using SJ of *Colocasia macrorhizos*; (J) Agarbathi using SJ of *Homalomena aromatica*;(K) Agarbathi made with SJs showing in containers; (L) Determination of burning time using stopwatch; (M & N) Agarbathi made in machine using SJ.

Conclusion

The study was performed with a series of experiments as per BIS guidelines using substitute Jigat (SJ) covering all standards of physical characteristics like stickiness, odor, visual inspection during storage, burning ability & time, etc, with a view to standardize proportion substitute Jigat. There is a future research need to evaluate amount of smog produce by the agarbathi prepared using the SJs. It was observed that unscientific collections from wild had led to the threat of species extinction and inflicted severe genetic

impoverishment among the wild populations. Harvesting of bioresources from wild or forests ensuring sustainability is a multifarious matter and need to analyze many dimensions, and have to be in accordance with social and ecological regime. Therefore, cultivation or farming of wild plant species may be a vibrant measure to the pressure off wild stocks. In other words harvesting is to be done only by cultivated or domesticated sources of wilds to utilize for making of substitute Jigat.

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