Potpourri as a Sustainable Plant Product: Identity, Origin, and Conservation Status[1]

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Potpourri as a Sustainable Plant Product: Identity, Origin, and Conservation Status. While displays of decorative dried plant material are popular in homes in Europe and North America, knowledge regarding potpourri ingredients is limited. This study examined the identity, diversity, origin, economic sources, and sustainability of such ingredients used in the United Kingdom (UK). Research at the Royal Botanic Gardens, Kew, commencing in 1990 and involving 1,000 samples of individual potpourri ingredients from 12 UK manufacturers and traders, revealed 546 different ingredients, representing up to 455 species, 289 genera, and over 100 families. Despite the wide taxonomic spread, several distinct plant part–family groups contributed the most potpourri ingredients: i.e., fruits from Arecaceae, Fabaceae, Malvaceae, Pinaceae, Poaceae, and Rutaceae; seeds from Fabaceae; leaves from Arecaceae, Fabaceae, and Poaceae; inflorescences from Asteraceae; as well as stems from cane, pith, timber, and pole wood. The vast majority of ingredients imported from Asia, especially India, were byproducts from crops and wild harvested species used by the Indian herbal healthcare industry. Global conservation assessments are lacking for 80% of wild collected Indian potpourri species, and those that have assessments are mainly abundant and widespread in ruderal or wetland habitats and of Least Concern (IUCN 2013), except *Pterocarpus marsupium* and *P. indicus* (Fabaceae), which are vulnerable globally, and *Calamus andamanicus* (Arecaceae) and *Oroxylum indicum* (Bignoniaceae), which are vulnerable nationally within India. A further eight, primarily medicinally traded species, are regarded as threatened within individual Indian states. Additional unique potpourri ingredients were sourced from Thailand, but only about one-tenth of study samples were from Africa, Middle East, Europe, America, and Australia. Temporal studies of potpourri ingredients could reflect changes in the use and abundance of species in other trades such as medicines, food, and materials.

Key Words: Non-timber forest products, United Kingdom, India, Thailand, plant families, plant parts, wild collected, crops, conservation status, Indian herbal healthcare industry, ethnobotany.

Introduction

Potpourri (a mixture of dried plant materials displayed in bowls in homes for decoration, color, and fragrance) has a history in Europe and North America dating back to at least the mid-18th century. Traditionally, fragrances and colors were inherent in locally gathered materials, e.g., lavender flowers and rose petals (Black and Dann 1989). Since the 1990s, many commercial potpourri packs sold in the United Kingdom (UK) contain imported ingredients that originate (almost entirely) from the tropics and include non-floral plant materials, algae, fungi, and lichens, to which manufactured dyes and fragrances are added. Despite significant visibility within trade, estimated at 600 tons and GBP 50 million per year (Hastings 2001), exotic plant materials used in UK potpourri are understudied, except for one study of palm ingredients (Cook 2007). Tucker et al. (2010) indicated that almost anything that is botanical, structurally interesting, and/or inexpensive, such as lawn sweepings and waste products from other industries, can be included in modern potpourri. This current study considers the following questions: are exotic potpourri ingredients likely to exhibit particular botanical characteristics, be from distinct geographical regions, or represent wastes from specific economic sectors?

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Furthermore, are supplies sustainable, and do they originate from crops or wild collected species? Ultimately, can potpourri studies indicate likely over-collected species to target for future conservation studies?

Since 1990 the Royal Botanic Gardens, Kew, has worked with 12 companies to help inform their selection of safe and sustainable materials for potpourri sold in the UK. Kew's resultant collection of potpourri samples, reflecting the diversity of plant ingredients traded, were studied in an attempt to answer some of the above research questions with respect to the UK market.

Methods

Morphological Identification of Potpourri Ingredients

Over a period of 20 years, a large collection of 1,000 individual potpourri ingredient samples received from manufacturers was accessioned in Kew's Economic Botany Collection (accession numbers PP 1–1017). It was possible to identify the majority of samples to species, to assign families (those for angiosperms follow Haston et al. [2009]), and to determine plant parts used. Potpourri manufacturers provided additional data including geographical sources (58% of samples) and suggested Latin scientific names (33%).

Identification of potpourri trade samples is challenging as most are incomplete botanical specimens (usually based on one plant part or fraction) and frequently altered in a variety of ways, including bleaching, coloring, and reshaping. Ingredient traceability and voucher herbarium specimens for potpourri trade ingredients are not available, so identifications in this paper are mainly based on finished ingredients only.

The majority of samples were identified by morphological comparison to botanical items in Kew's scientific collections (including herbarium, carpological, economic botany, and anatomical), often with help from specialist taxonomists and photographic publications on modern dried floristry materials that include some potpourri species (Rohrer 1984; Sprunger 2003; Sprunger and Wieler 1992; Tucker et al. 2010). For more difficult samples, identification was sometimes confirmed by anatomical analysis, but usually more complete specimens were requested from suppliers. Unfortunately, these were often still inadequate, infertile specimens, but as they were preprocessed, extra features sometimes aided identification.

Primary Uses and Conservation Status

Sustainability issues relating to potpourri species from India (the major source country for UK-traded potpourri) were studied. From literature reports, primary uses for Indian potpourri species were researched and it was determined whether these were crops or wild species. Here the term "crop" includes farm forestry, plantation, and ornamental species as well as agricultural crops. Unfortunately the literature sometimes uses "wild collected" loosely to include harvests from introduced and naturalized species, and even extends to harvests of non-wood parts such as fruits and leaves from plantation timber species or ornamentals. However, conservation assessments are only pertinent to wild, native species and not to crops. References consulted regarding native and introduced status of Indian species include Dixit (c. 1984), Karthikeyan et al. (2009), Singh et al. (2000), and Ved and Goraya (2008). Conservation status of wild collected Indian-sourced potpourri species at global, Indian national, and regional levels was collated with reference to the IUCN Red List 2013.2 (IUCN 2013), Rao et al. (2003), Ravikumar and Ved (2000), and various CAMP workshops (ENVIS–FRLHT 2012). A detailed Red Data List with assessments for the whole Indian flora is lacking, but the above sources identify obviously threatened species.

Results and Discussion

Of the 1,000 potpourri samples studied in Kew's Economic Botany Collection, 899 were identified to genus or species and 2 were identified to tribe. A further 99 were not identifiable but were classified into 71 separate ingredients. Overall the samples included 546 unique potpourri ingredients, representing a minimum of 430 and a maximum of 455 different species and at least 289 genera and 100 families. (Note: more than one potpourri ingredient can occur per species, representing use of different plant parts.)

Of the 331 Latin scientific names supplied by industry, at least 46 were incorrect. Mistakes were not only at the species level, but the supplied genus name was incorrect in 33 cases, and for 13 the suggested genus was from a different plant family to the identified family of the sample. Furthermore, names supplied by industry were often incorrectly

spelled. However, use by exporters of local botanical expertise to label plant ingredients with Latin scientific names is a positive step.

Taxonomic Groups

The vast majority of potpourri ingredients in this study (492) were angiosperms, 28 were gymnosperms, and a few were ferns (8), fungi (8), lichens (5), bryophytes (4), and algae (1). Around one-half (51%) of ingredients were from just 9 plant families, and 73% were from just 22 (see Fig. 1). The remaining 78 families were represented sparsely, with only 1 or 2 ingredients in each.

Plant Parts

The frequency of potpourri ingredients classed by plant parts are shown in Fig. 2. Several distinct, plant part–family groups (e.g., Fabaceae fruits) contributed much more to potpourri than others; these are discussed below.

Infructescence, Fruits, and Fruit Parts

Nearly half of all potpourri ingredients were fruit related, and about one-quarter related to fruits from 7 families: Fabaceae, Malvaceae, Arecaceae, Pinaceae, Poaceae, Rutaceae, and Cucurbitaceae.

Empty fruits, follicles, and valves (byproducts from extraction of seeds or fruit pulp for various uses) serve as robust bulking materials that can survive the potpourri production mixing process. *Acacia auriculiformis* A. Cunn. ex Benth. (Fabaceae) and *Gossypium* (Malvaceae) were particularly frequent and well regarded for this, but others included *Leucaena leucocephala* (Lam.) de Wit (Fabaceae), *Ceiba pentandra* (L.) Gaertn., and *Sterculia* (Malvaceae). Terminal parts of female cones and separated seed scales of *Cedrus* (Pinaceae) serve a similar purpose. Fragments (endocarp, mesocarp, or perianth) from fruits of *Cocos nucifera* L., *Areca catechu* L., and *Borassus flabellifer* L. (Arecaceae) are similarly robust and, additionally, are utilized as absorbers of fragrances and dyes in potpourri mixes. More unusual fruit byproducts included the fibrous vascular network from *Luffa* spp. (Cucurbitaceae) and fruit vein tissue and stalk from *Tamarindus indica* L. (Fabaceae).

Whole fruit potpourri ingredients serve a more decorative purpose and are often hand-placed as eye-catching "toppers" within mixes. Examples include cones from *Picea, Pinus, Larix,* and *Tsuga* (Pinaceae),

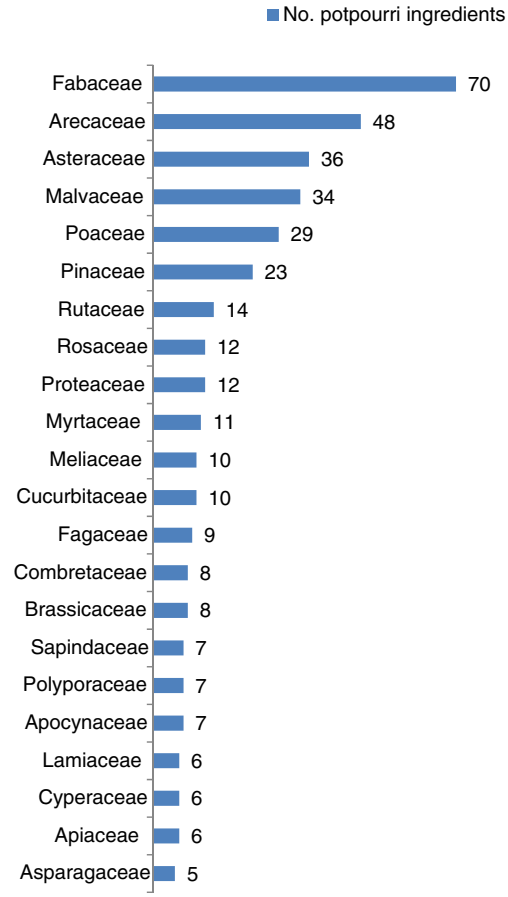

Fig. 1. The 22 most frequently represented families in UK potpourri (out of the 100 identified) that account for 73% of potpourri ingredients in this study.

cone-like fruits and/or fruiting branches of *Calamus, Daemonorops*, *Phoenix sylvestris* (L.) Roxb., *Mauritia flexuosa* L.f., *Raphia* and *Trachycarpus* (Arecaceae), cereal infructescences of *Avena, Echinochloa, Pennisetum, Setaria, Sorghum bicolor* (L.) Moench, *Triticum,* and *Zea mays* L. (Poaceae), winged fruits of *Pterocarpus* spp. (Fabaceae), dried, fleshy fruit slices of *Citrus* spp. and *Aegle marmelos* (L.) Corrêa (Rutaceae), and even entire or sliced gourds and pumpkins, *Cucurbita pepo* L. and *Lagenaria siceraria* (Molina) Standl. (Cucurbitaceae).

Leafy Stems, Leaves, or Leaf Parts

Although leaves are sought-after potpourri ingredients providing contrasts of shape and color, manufacturers often expressed difficulties in sourcing these.

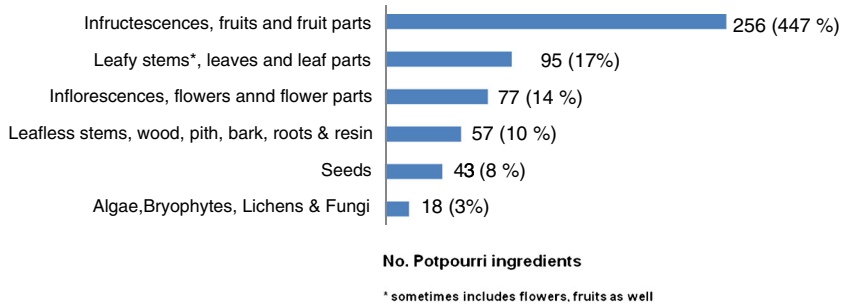

Fig. 2. Plant parts represented in UK potpourri ingredients.

Ingredients in this study included leaves and leaflets (64), leafy stems (25) and skeleton leaves, husks, and sheaths (6) sourced from 34 families, with 54% from eight: Arecaceae, Fabaceae, Poaceae, Asparagaceae, Myrtaceae, Pinaceae, Moraceae, and Adiantaceae. The most popular leaf sources were *Borassus flabellifer* (14 samples) and *Samanea saman* (Jacq.) Merr. (12).

Inflorescences, Flowers. and Flower Parts

Relative to fruit-based ingredients, floral elements in potpourri were less significant. In all, 24 families contributed 77 floral ingredients, but 42% were sourced from the Asteraceae, from genera with established value in the wider decorative dried floristry industry including *Bracteantha* (strawflowers), *Tagetes* (marigolds), *Sphaeranthus* (globe flowers), and *Zinnia* (zinnias).

Seeds

Of 43 seed potpourri ingredients, the majority (21) were sourced from Fabaceae, notably commercial peas and beans: *Lens, Phaseolus, Pisum, Trigonella, Vicia,* and *Vigna*. Samples were usually loose seeds but, for *Trigonella foenum-graecum* L. and *Vigna radiata* (L.) R. Wilczek, seeds were stuck on plastic balls to form decorative "toppers" which provide bulk in potpourri packs. Seeds from Brassicaceae (*Brassica juncea* (L.) Czern.), Pedaliaceae (*Sesamum indicum* L.), and mericarps of Apiaceae (*Cuminum cyminum* L. and *Foeniculum vulgare* Mill.) were used similarly.

Others

Other (non-seed) spherical toppers occurred, including whole fruit-rinds of *Aegle* and *Limonia* (Rutaceae), thin slices of *Aeschynomene aspera* L. pith (shola or sola) glued onto plastic balls, woven fruit valves of *Leucaena leucocephala,* and woven leafless stems from climbing plants generally known as latas in India. Lata stems are woven into other shapes too and are frequent in potpourri catalogues (e.g., Global Dried Flowers n.d.). The slender, wiry branches of *Finlaysonia obovata* Wall., a non-timber forest product (NTFP) used for baskets, fishing nets, binding, and tying (Nair 2000), is one possibility; however, identifications of leafless-stem items in this study were not confirmed and many species may be used. Sola pith items also varied from short remnant lengths of pith, to small artificial flowers and ornaments, to the covered balls described above. These probably originate from the craft industry in West Bengal, India, which produces ornaments, models, toys, and headgear from pith (CSIR 1985–1988).

The most common bark ingredients were identified as the inner bark of *Cinnamomum* species and *Carica papaya* L., and, regarding algae, bryophytes, fungi, and lichens, most frequent were fruiting bodies of the fungi *Microporus xanthopus* (Fr.) Kuntze and *Daedalea quercina* (L.) Pers., and the lichen *Cladonia*.

Geographical Origin

Figure 3 shows at least 48% of the UK potpourri samples in this study were sourced from Asia compared to 10% from outside Asia. Furthermore, this Asian percentage is likely to be a considerable underestimate as identifications of samples with unrecorded origins concurred more frequently with Indian or Thai species than those from other regions. Details of regional patterns are summarized below.

Asia

The vast majority of the 482 Asian potpourri samples in this study were from India (77–82%) and Thailand (16–22%), with the remaining 1%

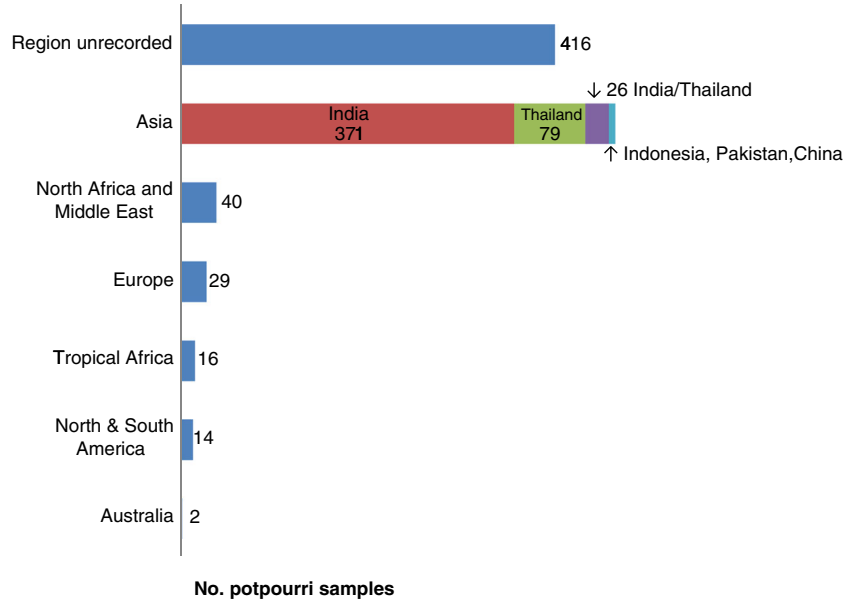

Fig. 3. Region of origin of 1,000 potpourri samples (country origins given for Asia).

shared between Indonesia, Pakistan, and China. At least 145 potpourri taxa were recorded from India and up to 73 from Thailand. While many Thai-sourced taxa were also sourced from India, 32 were uniquely sourced from Thailand. The majority of Thai ingredients were accessioned post-2002, when some of UK's potpourri manufacturing relocated to Thailand. Thailand imports ingredients from India for this, but evidence suggests more local ingredients are sought too. *Barleria strigosa* Willd., *Camchaya* sp., *Congea tomentosa* Roxb., *Daemonorops jenkinsiana* (Griff.) Mart., *Durio zibethinus* L., *Hibiscus sabdariffa* L., *Lagerstroemia speciosa* Pers., *Neohouzeaua mekongensis* A. Camus, *Neuracanthus tetragonostachys* Nees, *Phoenix* sp., possibly *P. loureiroi* Kunth and *Rumohra adiantiformis* (G. Forst.) Ching are examples of such potpourri ingredients sourced from Thailand only.

There is little doubt that the majority of UK potpourri ingredients originating from India derive mainly from byproducts, surpluses, and rejects of materials used by the Indian herbal healthcare industry (IHHI). The IHHI produces human and veterinary herbal medicines of single and multispecies drug formulations, as well as hair, skin, and oral care products such as shampoos, toothpastes, and cosmetics, and also nutraceuticals. Four main sources (see Table 1) include:

1) Species used in the manufacture of standardized pharmaceutical extracts (Khare 2007), including *Ammi visnaga* (L.) Lam. for amiodarone, nifedipene, and cromolyn, *Capsicum annuum* L. for capsaicin, *Pimenta dioica* (L.) Merr. for eugenol, *Reissantia* for pristimerin, and also *Lycopodium* spores used in pharmaceutical products;
2) Species listed in the official herbal pharmacopoeias of India for Ayurveda, Unani, and Siddha (Dept. of AYUSH, India 1999–2011, 2007–2009, and 2008–2011, and Indian Council of Medical Research, 2003–2014);
3) Close relatives, confused species, substitutes, and alternatives to pharmacopoeia species;
4) Additional species recorded to be sold in Indian medicinal plant markets by Ved and Goraya (2008), including medicinal herbs and plants used for oils, gums, waxes, proteins, starches, and dyes by the IHHI, plus further IHHI species, not listed in Ved and Goraya's (2008) market study, such as *Sorghum bicolor, Theobroma cacao* L., and *Triticum aestivum* L. (*Sorghum* is used in the production of malt extract [Indian Pharmacopoeia 2010] and *T. cacao* is used for cocoa butter). Similarly, several non-

TABLE 1. SCIENTIFIC AND COMMON NAMES (NOT TRADE NAMES) FOR SPECIES OF UK POTPOURRI INGREDIENTS EXPORTED FROM INDIA, GROUPED BY THE ECONOMIC SECTORS THAT ARE PROBABLE SOURCES. SPECIES LISTED IN THE LEFT-HAND COLUMN ARE WILD COLLECTED, THOSE IN RIGHT-HAND COLUMN ARE CROPS, AND THE CENTER COLUMN LISTS SPECIES WHICH OCCUR BOTH AS WILD COLLECTED AND AS CROPS. CROPS INCLUDE INDIAN AGRICULTURAL CROPS AND FARM FORESTRY, PLANTATION, AND ORNAMENTAL SPECIES; CROPS IMPORTED INTO INDIA ARE INDICATED WITH * AND COUNTRY OF ORIGIN IS PROVIDED. DEPT. OF AYUSH, INDIA (1999–2011; 2007–2009; 2008–2011) AND INDIAN COUNCIL OF MEDICAL RESEARCH (2003–2014) WERE REFERRED TO FOR LISTS OF INDIAN HERBAL PHARMACOPOEIA SPECIES.

WILD COLLECTED	CROPS/WILD COLLECTED	CROPS
A. INDIAN HERBAL HEALTHCARE INDUSTRY SPECIES		
1. Species used for commercial pharmaceutical extracts (see Appendix in Khare 2007)		
Lycopodium sp. **(club moss)** *Reissantia* sp.	*Ammi visnaga* (L.) Lam. **(khella)**	*Capsicum annuum* L. Longum group **(chilli pepper)** *Pimenta dioica* (L.) Merr. **(allspice)**
2. Indian herbal pharmacopoeia (Ayurveda, Siddha, and Unani) species and genera		
Boswellia serrata Roxb. ex Colebr. **(Indian frankincense)** *Butea monosperma* (Lam.) Taub. **(bastard teak)** *Calamus* sp. **(rattan)** *Cedrus deodara* (Roxb. ex Lamb.) G.Don **(deodar)** *Helicteres isora* L. **(Indian screw tree)** *Oroxylum indicum* (L.) Kurz **(midnight horror)** *Pterocarpus* sp. likely includes *P. marsupium* Roxb. **(Indian kino tree)** *Sphaeranthus indicus* L. **(East Indian globe thistle)** *Sterculia* sp. possibly *S. urens* Roxb. **(karaya)** *Strychnos nux-vomica* L. **(nux vomica)**	*Aegle marmelos* (L.) Corrêa **(bael, Bengal quince)** *Bombax ceiba* L. **(silk cotton tree)** *Borassus flabellifer* L. **(palmyra palm)** *Calophyllum* sp. likely *C. inophyllum* L. **(Alexandrian laurel)** *Catunaregam spinosa* (Thunb.) Tirveng. (syn. *Gardenia latifolia* Schltdl. ex Hook.f.) **(papra)** *Ficus benghalensis* L. **(banyan)** *Ficus religiosa* L. **(peepul)** *Juniperus* sp. [and Indian imports *] **(juniper)** *Limonia acidissima* L. **(wood apple)** *Millettia pinnata* (L.) Panigrahi (syn. *Derris indica* (Lam.) Bennet, *Pongamia glabra* Vent., *P. pinnata* (L.) Pierre) **(Indian beech, pongam oil tree)** *Nelumbo nucifera* Gaertn. **(sacred lotus)** *Pandanus sp.* **(screw pine, pandan)** *Punica granatum* L. **(pomegranate)** *Shorea robusta* Gaertn. **(sal)** *Sida acuta* Burm.f. **(sweet berela)** *Spondias pinnata* (L.f.) Kurz **(Indian hog plum)** *Tamarindus indica* L. **(tamarind)** *Terminalia alata* Heyne ex Roxb. **(Indian laurel)**	*Albizia lebbeck* (L.) Benth. **(Indian siris)** *Aloe sp.* likely *A. vera* (L.) Burm.f. **(aloe vera)** *Areca catechu* L. **(betel palm)** *Carica papaya* L. **(pawpaw)** *Carissa carandas* L. **(karanda)** *Celosia argentea* L. **(cockscomb)** *Cinnamomum* sp. some likely *C. verum* J.Presl **(cinnamon)** *Cocos nucifera* L. **(coconut)** *Coriandrum sativum* L. **(coriander)** *Elettaria cardamomom* (L.) Maton **(cardamom)** *Eucalyptus* spp. **(eucalyptus)** *Gossypium* sp. **(cotton)** *Illicium verum* Hook.f. **(star anise)** *Luffa acutangula* (L.) Roxb. **(angled luffah)** *Musa* sp. **(banana)** *Pennisetum glaucum* (L.) R.Br. (syn. *P. typhoides* (Burm.f.) Stapf & C.E.Hubb.) **(pearl millet)** *Senna alexandrina* Mill. (syn. *Cassia angustifolia* M.Vahl) **(senna)** *Sesamum indicum* L. **(sesame)** *Thespesia populnea* (L.) Sol. ex Corrêa **(portia tree)** *Thymus* spp. **(thyme)**

(Continued)

TABLE 1. (CONTINUED).

WILD COLLECTED	CROPS/WILD COLLECTED	CROPS
		Zingiber officinale Roscoe **(ginger)**
3. Close relatives, confused species, substitutes, and alternatives for Indian herbal pharmacopoeia species		
Millettia extensa (Benth.) Benth. ex Baker	*Dactyloctenium aegyptium* (L.) Willd. **(Egyptian crowfoot grass)**	*Alcea rosea* L. (syn. *Althaea rosea* (L.) Cav.) **(hollyhock)**
Pterocarpus spp. (likely includes *P. indicus* Willd.,	*Sapindus trifoliatus* L. **(soapnut)**	*Luffa cylindrica* (L.) M.Roem. **(smooth luffah)**
P. macrocarpus Kurz) **(bastard teak, gum kino)**		*Pterocarpus soyauxii* Taub. (West Africa)*
Sterculia sp., possibly *S. villosa* Roxb. **(udal)**		
4. Additional Indian medicinal plant market species listed in Ved and Goraya 2008 (plus close relatives and other probable IHHI species †)		
Bauhinia tomentosa L. **(yellow bauhinia)**	*Cochlospermum religiosum* (L.) Alston **(silk cotton tree)**	*Abelmoschus esculentus* (L.) Moench **(okra)**
Combretum spp. **(combretum)**	*Corchorus* sp. possibly *Corchorus oliotorius* L. **(jute)**	*Ceiba pentandra* (L.) Gaertn. **(kapok)**
Dodonaea sp. **(hopbush)**	*Dioscorea* sp. probably *Dioscorea alata* L. **(yam)**	*Cucurbita pepo* L. **(squash, pumpkin)**
Dysoxylum gotadhora (Buch.-Ham) Mabb.	*Flemingia strobilifera* (L.) W.T.Aiton **(wild hops)**	*Delonix regia* (Hook.) Raf. **(flame tree)**
(syn. *D. binectariferum* Hook.f. ex Bedd.)	*Pinus kesiya* Royle ex Gordon **(khasi pine)** †	*Helianthus annuus* L. **(sunflower)**
Ichnocarpus frutescens (L.) W.T.Aiton (unconfirmed identification)	*Pinus wallichiana* A.B. Jacks **(Bhutan pine)** †	*Phoenix sylvestris* (L.) Roxb. **(date palm)**
Lagerstroemia sp. possibly *L. parviflora* Roxb.		*Pinus nigra* J.F.Arnold **(Austrian pine)** †
Schrebera swietenioides Roxb. **(weaver's beam tree)**		*Setaria italica* (L.) P.Beauv. **(foxtail millet)**
Soymida febrifuga (Roxb.) A.Juss. **(Indian redwood)**		*Sorghum bicolor* (L.) Moench **(sorghum)**†
Terminalia alata Heyne ex Roxb. **(Indian laurel)**		*Tagetes erecta* L. **(African marigold)**
Wattakaka volubilis (L.f.) Stapf (syn. *Dregea volubilis* Benth. ex Hook.f.)		*Theobroma cacao* L. **(cacao)** †
		Triticum aestivum L. **(wheat)** †
		Zea mays L. **(corn)**
B. CRAFT MATERIALS AND WOOD SPECIES (Plantation timbers †; Farm forestry species)		
Aeschynomene aspera L. **(shola, sola)**	*Combretum* spp. **(combretum)**	*Acacia auriculiformis* A.Cunn. ex Benth. **(Australian wattle)**
Calamus acanthospathus Griff. **(rattan)**	*Terminalia alata* Heyne ex Roxb. **(Indian laurel)**	*Alnus* sp. **(alder)***
Calamus viminalis Willd. **(rattan)**		*Araucaria cunninghamii* Aiton ex D.Don **(hoop pine)** †
Daemonorops sp.		*Casuarina equisetifolia* L. **(Australian pine)**
Finlaysonia obovata Wall. **(lata)**		*Leucaena leucocephala* (Lam.) de Wit **(leucaena)**
Schoenoplectus sp. **(rush)**		
		Raphia sp. **(raffia)**
		Raphia farinifera (Gaertn.) Hyl. **(raffia palm)**
		Swietenia macrophylla King **(big leaf mahogany)** †

(Continued)

TABLE 1. (CONTINUED).

WILD COLLECTED	CROPS/WILD COLLECTED	CROPS
C. DRIED FLORISTRY SPECIES		
Calamus andamanicus Kurz **(rattan)**	*Gomphrena globosa* L. **(globe amaranth)**	*Anaphalis* sp. **(everlasting)**
Daedalea quercina (L.) Pers. **(oak maze gill fungus)**	*Tithonia sp.* **(Mexican sunflower)**	*Bougainvillea* sp. possibly *B. spectabilis*
Lentinus polychrous Lév. **(polypore fungus, white rot fungus)**	*Picea smithiana* (Wall.) Boiss. **(West Himalayan spruce)**	Willd. **(bougainvillea)**
Lenzites acuta Berk. **(polypore fungus)**		*Bracteantha bracteata* (Vent.) Anderb. & Haegi **(strawflower)**
Microporus xanthopus (Fr.) Kuntze **(yellow footed polypore)**		*Casuarina equisetifolia* L. **(Australian pine)**
Polystichum sp./p. **(shield fern)**		*Grevillea* sp. **(grevillea)**
Pteridium aquilinum (L.) Kuhn **(bracken fern)**		*Gypsophila paniculata* L. **(baby's breath)**
		Jacaranda mimosifolia D.Don **(jacaranda)**
		Picea omorika (Pancic) Purk. **(Serbian spruce)***
		Samanea saman (Jacq.) Merr. **(saman, rain tree)**
		Tillandsia usneoides (L.) L. (North America) **(Spanish moss)***
		Tsuga sieboldii Carrière/*T. dumosa* (D.Don) Eichler **(Japanese hemlock)**
D. SPECIES WHERE SOURCE ECONOMIC SECTOR IS UNCERTAIN		
Calamus andamanicus Kurz **(rattan)**	*Annona squamosa* L. **(sugar apple)**	*Acacia binervia* (Wendl.) J.F.Macbr. (Australia) **(coast myall)***
Cardiopteris quinqueloba (Hassk.) Hassk.	*Caryota urens* L. **(kitul, toddy palm)**	*Artocarpus altilis* (Parkinson ex F.A. Zorn) Fosberg **(breadfruit)**
Cerbera odollam Gaertn. **(suicide tree)**	*Corchorus* sp. possibly *Corchorus oliotorius* L. **(jute)**	*Helichrysum stoechas* (L.) Moench (Europe) **(shrubby everlasting)***
Cheilanthes farinosa (Forssk.) Kaulf. **(fern)**		*Hyphaene compressa* H.Wendl. (E. Africa) **(East African doum palm)***
Combretum spp. **(combretum)**		*Larix gmelinii* (Rupr.) Kuzen. (E. Asia) **(Dahurian larch)***
Heritiera littoralis Aiton **(looking glass mangrove)**		*Magnolia sieboldii* K.Koch (E.Asia) **(Siebold's magnolia)***
Pterygota sp. **(Buddha's coconut)**		*Pterocarpus rotundifolius* (Sond.) Druce (Southern Africa) **(round-leaved bloodwood)***
Schima wallichii Choisy **(needlewood)**		*Spathodea campanulata* P.Beauv. (West Africa) **(African tulip tree)***
Sparganium stoloniferum (Buch.-Ham.ex Graebn.) Buch.-Ham. ex Juz. (syn. *S. erectum* (Buch.-Ham.ex Graebn.) H.Hara ssp. *stoloniferum* (Buch.-Ham. ex Graebn.) H.Hara) **(bur-reed)**		*Trachycarpus fortunei* (Hook.) H.Wendl. **(windmill palm)**
Sterculia macrophylla Vent.		*Zollingeria dongnaensis* Pierre (Thailand)*

pharmacopoeia species of *Pinus* (*P. kesiya* Royle ex Gordon, *P. nigra* J.F. Arnold, and *P. wallichiana* A.B. Jacks), absent from Ved and Goraya's market list, occur in potpourri. These species are likely used by the IHHI in general pine oils that are used as aromatics (Leung and Foster 1996).

Although the majority of UK potpourri items sourced from India relate to medicinal or healthcare species, a significant number relate to species used in wood production (Table 1). Occasionally these include plantation timber species such as mahogany, *Swietenia macrophylla* King, and hoop pine *Araucaria cunninghamii* Aiton ex D. Don, but more often are popular farm forestry species, e.g., *Acacia auriculiformis*, *Alnus* sp., *Casuarina equisetifolia* L., *Combretum* spp., *Leucaena leucocephala,* and *Terminalia alata* Heyne ex Roxb. In general, potpourri items from such species involve fruits and leaves, most likely byproducts from wood production. According to Saigal et al. (2002), when farm forestry was first introduced into India in the 1970s, regulation of the felling of trees and transport of forest produce inhibited its success, but during the 1980s, in various Indian states, popular farm forestry species often became exempt from restrictive transit and felling permit rules. Many ingredients in this post-1990 potpourri study seem to reflect this change in regulation.

Other potpourri items derive from remnant short lengths of materials from craft industries, including rattan cane stems (from *Calamus acanthospathus* Griff. and *C. viminalis* Willd.), "lata" stems (possibly from *Finlaysonia obovata* or other species), and shola pith from *Aeschynomene aspera*. Similarly, flowers from *Schoenoplectus* may be byproducts from preparation of matting from their stems. Surprisingly few Indian-sourced UK potpourri ingredients are also used in the dried floristry trade, but examples listed in Table 1 involve a wide range of plant parts: inflorescences, flower heads, bracts, fruits, cones, leaves, leafy stems, and several fungi. Although *Tillandsia usneoides* (L.) L. is imported into India from Northern and Central America, some is likely re-exported.

Not all UK potpourri species sourced from India could be allocated to a single, specific economic sector (see Table 1, section D). For instance, for *Cerbera odollam* Gaertn. there are several possibilities: medicine, biofuel, or primary-use dried floristry. However, this cardioactive species is known more for its toxicity and use in homicide and suicide (Gaillard et al. 2004) than for medicinal uses, and Lemmens (2006) concludes that there is little future for *Cerbera* spp. in medicines (other than local uses) due to the availability of similar, less toxic compounds in other species. However, Kansedo et al. (2009) describe *C. odollom* as a promising non-edible feedstock for biodiesel production.

North Africa and Middle East

From North Africa and the Middle East, Israel was found to be the main supplier (31 samples), followed by Morocco (4), Turkey (2), Iran (2), and Egypt (1). Israeli samples were mainly from agricultural crops including edible fruits (*Citrus* spp., *Cucurbita pepo, Malus domestica* Borkh., *Prunus persica* (L.) Batsch, *Psidium guajava* L., *Solanum melongena* L., and *S. aethiopicum* L.), nuts (*Juglans regia* L.), herbs (*Laurus nobilis* L.), cereals (*Zea mays*), and ornamentals (*Dahlia, Hydrangea, Leucanthemum, Viola,* and *Zinnia*). The Israeli bias reflects a specialist potpourri company that focused on items from Israel.

Europe

The 29 samples recorded from Europe were sourced from a wide range of countries: UK (7), France (5), Norway and Italy (each 3), Czech Republic (2), Russia, Poland, Portugal, Macedonia, and Hungary (each 1), and unknown (4 samples).

Ingredients included algae (*Chondrus* from France), lichens (*Cladonia* from Norway), and cork oak bark (*Quercus suber* L. from Portugal and Italy). Flowers were sourced from *Achillea* and *Consolida* (UK), *Chamaemelum* (France), *Erica*, *Malva*, and *Papaver* (Eastern Europe), and leafy stems from *Passiflora incarnata* L. (from Italy). Cereal samples included *Triticum aestivum* and *Phalaris canariensis* L. (both from the UK), and timber-related ingredients included stems and stem slices of *Betula* (from Russia), *Picea/Larix* (from Czech Republic), *Quercus* and *Salix/Populus* from Italy, and *Larix* bark from UK. Cone and leaf samples from *Pinus sylvestris* L. from France or Eastern Europe also occurred.

Tropical Africa

In all, 14 potpourri ingredients (21 samples) were sourced from tropical Africa: 10 from South Africa, 2 from Zimbabwe, and 1 from West Africa; the source of the remainder was unknown. Those from

South Africa (*Athanasia, Eucalyptus*, *Helichrysum, Leucadendron,* and *Protea* species) reflect the dried flower industry. Other African ingredients included entire baobab fruits (*Adansonia digitata* L.*)* and fruits of *Raphia hookeri* G. Mann & H. Wendl.

Americas and Australia

Fifteen ingredients (16 samples) originated from the Americas and Australia: 4 were from the US and Canada, 3 were Mexican, 7 Brazilian, and only 2 Australian (unsurprisingly *Acacia* and *Eucalyptus*). Brazilian ingredients included empty fruit cases of the Brazil nut (*Bertholletia excelsa* Bonpl.*)*, entire fruits of *Raphia taedigera* (Mart.) Mart., fruit capsules of *Jacaranda copaia* (Aubl.) D. Don, an empty fruit of *Parkia paraensis* Ducke, *Strychnos pseudoquina* A. St.-Hil. leaves, and inflorescences of *Syngonanthus* as well as the lichen *Parmotrema*. From North America were *Nolina texana* S. Watson leaves, *Tillandsia usneoides* (L.) L. aerial parts, and possibly stems of *Salix*.

Comparison of Potpourri Ingredients Marketed in UK and US

Tucker et al. (2010) carried out a survey of potpourri ingredients used in the United States and there are similarities to this study. Of the 215 species in the US study, 121 occur in the UK potpourri ingredient list and 94 do not. Conversely, over 200 ingredients in this UK study do not occur in the US study. UK ingredients not listed in Tucker et al. (2010) include many food crop species, many *Citrus* spp. and pulses, as well as other ingredients sourced from Eastern Europe, North Africa and Middle East, Africa, and Thailand. US ingredients not occurring in this UK study include many Australian and South American imports as well as local North American ingredients. However, many Indian species occur in both UK and US potpourri, suggesting that Indian sources are a mainstay for potpourri, while variations occur depending on geography and trade partners.

Conservation Issues: A Case Study Regarding Indian-Sourced UK Potpourri Ingredients

Overall approximately 65% of Indian potpourri taxa relate to taxa used in the IHHI as medicinal herbs or other ingredients (oils, dyes, gums, and starches) for herbal formulations and products. These taxa include crops (both Indian and imported) and NTFPs for which there is a long-standing tradition of seasonal gathering within India. Traditionally, NTFP collection was for subsistence or local needs, but nowadays sales to industry provide a supplementary income for rural poor, often tribal people. Saigal et al. (2002), Subrat et al. (2002), and Ved and Goraya (2008) describe the Indian medicinal plant trade as an hierarchical network that consists of tens of thousands of traders, from collection agents at village level, to agents at road head markets or mandis, to stockists or agents who operate from medium mandis, to well-organized commission agents located in major cities such as Mumbai, Delhi, Chennai, and Kolkata. Commission agents often have their own storage facilities and tend to supply one or two major manufacturers in herbal healthcare. Payments to collectors are generally low as they are often several levels removed from the final buyer and may only get a fraction of the final price, often as little as 3% according to Saigal et al. (2002). There have been calls to encourage more direct links between collectors and processors (Subrat et al. 2002), and initiatives regarding this were reported by Ved and Goraya (2008). Importantly, Kuipers (1997) suggested that low prices obtained for seasonally gathered NTFPs may encourage gatherers to "mine" resources rather than sustainably manage them.

Table 1 shows that crops have the greatest representation within UK potpourri sourced from India (68 taxa), but wild collected Indian native taxa are significant too (48), and a further 35 can be both crops or wild collected. Unfortunately, for the 67 taxa identified to species (not just genus) that potentially contribute to wild collected potpourri ingredients, IUCN global Red List assessments are not available for 53 (79%) of these, so significant knowledge gaps need to be filled. From the 14 assessments available, 12 species were rated Lower Risk/least concern, illustrating that some wild-harvested potpourri species are not threatened; these include *Aeschynomene aspera, Calophyllum inophyllum* L., *Caryota urens* L., *Cedrus deodara* (Roxb. ex Lamb.) G. Don*, Heritiera littoralis* Aiton*, Millettia pinnata* (L.) Panigrahi, *Picea smithiana* (Wall.) Boiss., *Pinus kesiya* Royle ex Gordon, *Pinus wallichiana*, *Punica granatum* L., *Shorea robusta* Gaertn., and *Sphaeranthus indicus* L. (IUCN 2013).

Additionally several species within *Schoenoplectus* are also listed as Lower Risk/least concern (IUCN 2013). Many of these species occur in ruderal

TABLE 2. POTPOURRI SPECIES LINKED TO MEDICINALLY TRADED SPECIES OF CONSERVATION CONCERN WITHIN INDIAN STATES. (DATA COLLATED FROM CAMP WORKSHOP REPORTS REVIEWED BY ENVIS–FRLHT [2012].)

Species	Conservation status within Indian states (with date of CAMP report)	Traded in medicine	Potpourri parts	Number of potpourri samples
Aegle marmelos	Vulnerable - Maharashtra 2001, Karnataka 95/96/97/99, Tamil Nadu 95/96/97/98, Andhra Pradesh 2001	Leaf, Fruit, Bark	Fruits	11
Boswellia serrata	Vulnerable - Chhattisgarh 2003, Madhya Pradesh 2003/2006	Gum	Gum	1
Cochlospermum religiosum	Critically Endangered - Rajasthan 2007 Vulnerable - Madhya Pradesh 2003/2006, Chhattisgarh 2003	Gum	Fruit valves	2
Schrebera swietenioides	Vulnerable - Karnataka 95/96/97/99, Orissa 2007, Rajasthan 2007	Bark, Fruit	Fruits (halved capsules)	3
Shorea robusta	Near Threatened - Andhra Pradesh 2001	Resin, Bark, Fruits	Fruits	1
Sterculia urens	Endangered - Rajasthan 2007 Vulnerable - Madhya Pradesh 2003/2006, Andhra Pradesh 2001, Chhattisgarh 2003	Gum	Fruit follicles	6
Strychnos nux-vomica	Vulnerable - Chhattisgarh 2003	Seeds, Stem or bark	Fruits (empty)	1

environments degraded by humans. *Sphaeranthus indicus* is a widespread weed in terrestrial freshwater habitats, with stable populations and only local threats. *Aeschynomene aspera* is widespread and common in wetland margins and no specific threats are noted. Similarly, other species, currently not assessed globally or in India, are also widespread and common, e.g., *Bombax ceiba* L. (widely distributed in India), *Dodonaea viscosa* (L.) Jacq. (a pantropical weed), *Ichnocarpus frutescens* (L.) W.T. Aiton (throughout India to 1200 m), and *Lycopodium* spp. (wide ranging in Asia, Europe, and North America). However, the mangrove species *Heritiera littoralis*, although widespread and common globally, has a declining population trend, threatened by coastal development (Duke et al. 2010). Other mangrove potpourri species include *Helicteres isora* L., *Finlaysonia obovata*, and *Cerbera odollam,* and these may be similarly threatened by habitat change. Some local evaluations reflect this, e.g., CAMP reports for Orissa described *C. odollam* as vulnerable (ENVIS–FRLHT 2012). Table 2 lists additional potpourri species of conservation concern within Indian states. All are medicinal species traded at high volume except for *Cochlospermum religiosum* (L.) Alston which is traded at lower volumes (Ved and Goraya 2008). For some there is a close link between potpourri parts and traded medicinal parts, especially as byproducts.

At the Indian national level, *Oroxylum indicum* (L.) Kurz is classed as "vulnerable" (Rao et al. 2003) but has not been assessed globally by IUCN (2013). This medicinal species is traded in high volumes in India (Ved and Goraya 2008), primarily the roots but also seeds. The winged seeds were common in Kew's potpourri samples up to around 2004, but not subsequently. The decline may reflect reduced medicinal trade owing to possible demise in the wild. Global conservation assessments suggest that *Pterocarpus marsupium* Roxb., whose natural distribution is restricted to India and Sri Lanka, is probably of most concern. This is vulnerable v. 2.3 (IUCN 2013) largely on account of its wood which is used as timber and for its hypoglycemic properties, although the winged seeds are also traded medicinally in India (Ved and Goraya 2008). Fruits in potpourri are likely byproducts from wood harvest or surplus medicinal fruits. More detailed study of *Pterocarpus* fruits in trade may be worthwhile; Rojo (1972) distinguishes various fruit characters and

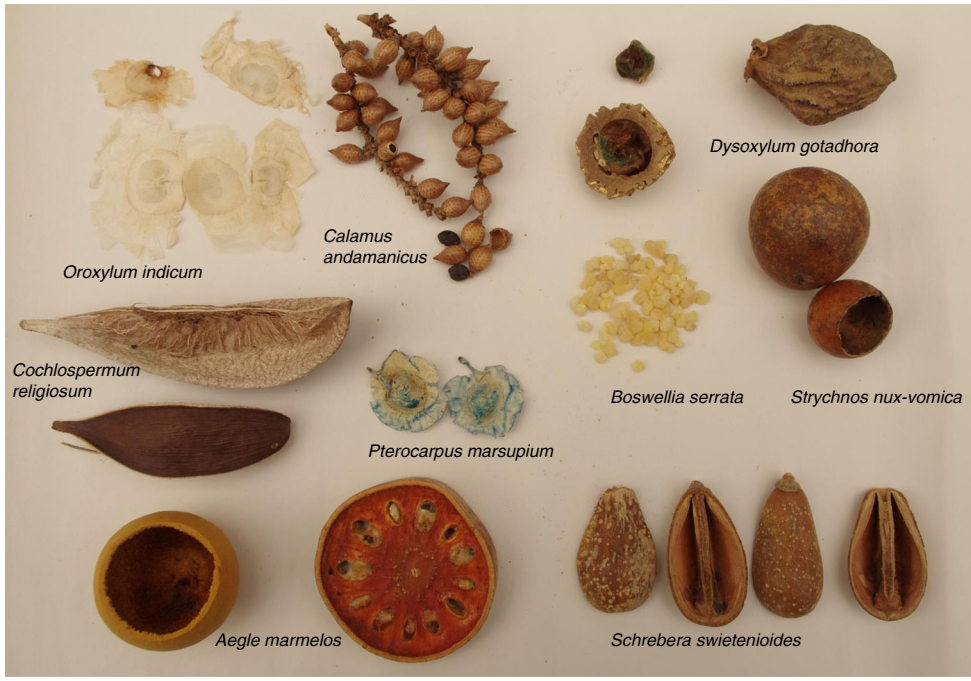

Fig. 4. Examples of potpourri ingredients from species of conservation concern particularly within India at national or state level: 1) *Oroxylum indicum* seeds EBC PP 551; 2) *Calamus andamanicus* infructescence EBC 634; 3) *Dysoxylum gotadhora* fruit and seed EBC PP 769; 4) *Dysoxylum gotadhora* fruit and seed EBC PP 777; 5) *Cochlospermum religiosum* fruit valves EBC PP 294; 6) *Pterocarpus marsupium* fruits EBC PP 740; 7) *Boswellia serrata* gum resin EBC PP 708; 8) *Strychnos nux-vomica* empty fruit EBC PP 150; 9) *Aegle marmelos* fruit rind EBC PP 70; 10) *Aegle marmelos* fruit with seeds and pulp EBC PP 695; 11) *Schrebera swietenioides* fruit capsules EBC PP 41.

P. marsupium, P. indicus Willd., and *P. macrocarpus* Kurz are likely represented in Kew's potpourri collection.

Dysoxylum gotadhora (Buch.-Ham.) Mabb. (synonym *D. binectariferum* Hook.f. ex Bedd.) is also of interest. This species has not been assessed globally. However, Ravikumar and Ved (2000) state that uses of *D. gotadhora* are similar to *D. malabaricum* Bedd. ex C. DC., which has wood used as a substitute for infected agar wood from the vulnerable v. 2.3, *Aquilaria malaccensis* Lam. (IUCN 2013). *D. malabaricum* is described as globally endangered by Ravikumar and Ved (2000), although it has not been assessed globally in the IUCN Red List (IUCN 2013), or by Rao et al. (2003) for India. Nevertheless, the fact that *D. gotadhora* samples occur in potpourri may indicate substitution of *D. malabaricum.* Further investigation on quality of medicinal products and conservation status of *Dysoxylum* species may be worthwhile.

Calamus andamanicus Kurz from the Andaman Islands is "vulnerable" in India (Rao et al. 2003) but is absent from Ved and Goraya's (2008) list of medicinally traded species. This species is valued in potpourri and floristry as the attractive small fruits remain on the stem better than other *Calamus* species. Harvest for floristry may be a contributory threat to this species, along with rattan uses (Fig. 4).

There is a need for further studies regarding the collection of wild, native species from natural habitats within India to ensure overcollection does not occur; the lack of conservation assessments for many species needs to be addressed even though initial studies suggest that wild collected species are more often common species, from ruderal or wetland habitats, with widespread distributions.

Conclusions

From 1,000 potpourri samples examined over a 20-year period it was possible to identify 546 different ingredients. These represent

492 angiosperms, 28 gymnosperms, 8 ferns, 5 lichens, 4 bryophytes, and 1 alga, and more than 100 families. This large diversity of ingredients to some extent supports the Tucker et al. (2010) viewpoint that more or less anything botanically interesting can be included in potpourri; however, botanical patterns in species representation occurred. Over 50% of ingredients were from just nine plant families and there was especially a preponderance of fruits from Arecaceae, Fabaceae, Malvaceae, Pinaceae, Poaceae, and Rutaceae; leaves from Arecaceae, Fabaceae, and Poaceae; inflorescences from Asteraceae; seeds from Fabaceae, and stems from material and timber producing species.

UK potpourri ingredients are sourced from many parts of the world but the vast majority are sourced from Asia, especially India. Thailand has recently become a base for manufacture of UK potpourri and unique Thai ingredients have emerged, but the majority of potpourri items are still byproducts from ingredients used by the Indian herbal healthcare industry (e.g., *Aegle marmelos, Areca catechu, Nelumbo nucifera* Gaertn., *Oroxylum indicum, Gossypium, Millettia pinnata, Pterocarpus, Soymida febrifuga* (Roxb.) A. Juss., *Thespesia populnea* (L.) Sol. ex Corrêa), while others are byproducts from species used in other natural product-based industries notably timber (e.g., *Araucaria cunninghamii*, *Swietenia macrophylla*), pole wood (*Acacia auriculiformis, Combretum spp., Terminalia alata*), cane (*Calamus* spp.), and shola pith (*Aeschynomene aspera*). In contrast to Asia, UK potpourri ingredients sourced from Africa, the Middle East, Europe, America, and Australia are relatively few. The identities of these ingredients suggest that many may be byproducts or surpluses from crops of fruits, nuts, herbs, cereals, ornamental flowers, and timbers.

There is a concern that an expansion of the IHHI coupled with the hierarchical system of trade in plants for this industry might result in overcollection in wild harvested species. However, distinction between Indian crop and wild harvested species is often blurred in the literature, and geographical status of "wild" harvested species needs to be checked to ensure they are not actually introduced, naturalized, or cultivated. Furthermore, international conservation assessments (IUCN 2013) are not available for almost 80% of wild collected Indian-sourced potpourri species, albeit many are common species with widespread distributions, often from ruderal or wetland habitats. Potpourri species for which there is concern include *Pterocarpus marsupium* at an international level and *Oroxylum indicum* at the Indian national level. Overall there is little evidence to suggest that the potpourri trade itself exerts direct pressure on wild species since its ingredients largely reflect direct use by other industries (e.g., food, medicines, and materials), but there is potential for potpourri packs to be a barometer of change in traded species. Such studies could reveal use of substitutes (e.g., use of *D. gotadhora* rather than *D. malabaricum* or *Aquilaria malaccensis*), predict a downturn in previously abundant species (e.g., *Oroxylum indicum*), or show changes in habitat representation (e.g., decline in mangrove species such as *Heritiera littoralis*, *Cerbera odollam,* and *Helicteres isora*).

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