International Journal of Minor Fruits, Medicinal and Aromatic Plants. Vol. 8 (2) : 01- 11, December 2022

Review article

Taxonomic diversity of spice crops available in Bangladesh Agricultural University Botanical Garden and their medicinal properties

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Received : 26.05.2022 ; Revised : 10.08.2022 ; Accepted : 12.08.2022

DOI : 10.53552/ijmfmap.8.2.2022.1-11

ABSTRACT

Spice crops have versatile economic uses and medicinal properties. People commonly use spices in the cooking of foods. Many spice crops were collected from home and abroad and are being conserved in Bangladesh Agricultural University Botanical Garden (BAUBG). A survey was carried out to update the list of spice crops available in BAUBG and to record their diversity, and economic and therapeutic uses.Thirty spice species identified in BAUBG belong to 16 families. A brief description of the therapeutic/medicinal uses of each species has been presented in the text.

Keywords: Bangladesh, Culinary Herbs, Medicinal Values, Spice, Therapeutic Properties

INTRODUCTION

Spices, the culinary agents, are used for seasoning or flavoring a food or curry either in dried, powdered, or fresh form. Bangladeshi people use and cultivate a taxonomically diverse group of spices and condiments in their homes as well as in the crop fields commercially to satisfy their daily needs. They also collect some of them from the wild vegetation (the natural forest). Most of the spices were found to be multi-purpose and were reported as they are used in medicine by local peoples for a long time. There is a significant demand for herbs and spices in the area because locals use a lot of them in their everyday culinary preparations.Spices are enriched with bioactive compounds that have high antioxidant properties and provide the potential to safeguard the human body (Shan *et al*., 2005). Spice crops produce secondary metabolites that may not be essential for their normal growth or function, but they are known to have anti-disease potential (Craig, 1999).

Often the fresh leaves of *Anethum graveolens, Coriandrum sativum*, *Cymbopogon citratus, Eryngium foetidum*, *Foeniculum vulgare, Mentha spicata*, and *Piper betle* are used as condiments. The seeds and roots of the spices and condiments are used both in dried and ground forms. The bulbs of Onion and Garlic are used in both fresh and dry conditions. *Capsicum annum* and *Capsicum frutescens* both are used as fresh vegetables or in dried and ground form (usually mixed with other spices and condiments). *Curcuma longa* L. and *Zingiber officinale* are used for their spicy rhizome and used either in dried or powdered forms.

The Bangladesh Agricultural University Botanical Garden (BAUBG)is the second-largest botanical garden in Bangladesh in terms of area, but the largest in terms of species. Presently, BAUBG conserves a total of 1800 species belonging to 287genera and 168 families. There are some species of spices that are also conserved in it. The majority of the spices are annual herbaceous plants, whereas just a small percentage are trees and some are a climber. This study attempts to catalog all the accessible spice plants at the BAUBG and describe their therapeutic/medicinal uses.

MATERIALS AND METHODS

Bangladesh Agricultural University Botanical Garden (BAUBG) is situated on the west bank of the old Brahmaputra River (Fig.1). The University is geographically located at 90°26’29.6’’E and 24°43’26.8’’N.It is dominated bya tropical monsoon climate having relative humidity between 80-84% and an average rainfall of about 2000 mm (Jone *et al*., 2022).

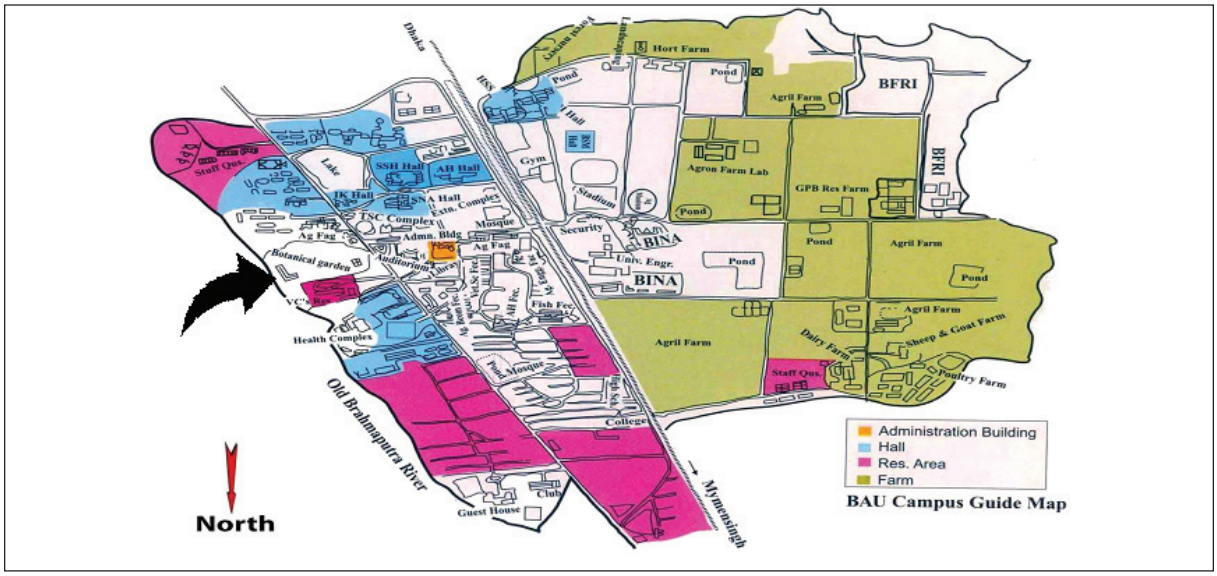

Fig. 1: Bangladesh Agricultural University map with the research area (BAUBG) marked by an arrow sign

The study has been planned to document the spice crops available in the BAUBG along with their taxonomic diversity, medicinal properties, and other uses. All the data presented in the text were formulated by visiting the garden and were re-checked with two websites named The Plant List (http://www.theplantlist.org/) and The Plants of World Online (https://powo.science.kew.org/). The genera and species under each family along with their medicinal uses have been described in alphabetical order. The valid name(s) of each species, its habit, and conservation status have been stated in tabular form.

RESULTS AND DISCUSSION

Thirty species under 23 genera belonging to 16 families of spice crops were found in BAUBG. About 54 per cent of the spices found in the garden are herbs, whereas 30% are trees, 13% are climbers, and 3% are shrubs. Apiaceae has the highest number of genera (4) followed byZingiberaceae(3), Myrtaceae(2), and Rutaceae (2). The rest 12 families have a single genus in each. Piperaceae has the maximum number of plants (5species) whereas nine families have single species (Fig. 2). Spices can be used as seeds, fruit, bark, or any other plant part for culinary or medicinal purposes. Seeds of almost all the 30 spice crops are used for culinary or medicinal purposes whereas single spices are used as bark and flower bud. In this section, we described the medicinal uses of 30 spice crops with graphs to classify them according to various classes.

For each taxon, the latest nomenclature, synonym, and uses have been included below.

***Allium cepa* L.:** Synonym : *Allium angolense* Baker, *Porrum cepa* (L.) Rchb.

Onion expressed antibacterial activity against pathogenic microorganisms. Aqueous and alcoholic extract of the onion bulb has powerful hepatoprotective properties. Eating onion regularly can reduce liver diseases. The unutilized outer layers of the red variety of onion are an important source of natural antioxidants (Miri and Roughani, 2018). Fresh onion juiceis used to reduce pain and inflammation (Upadhyay, 2016).(Fig: 5-A)

***Allium sativum* L.:** Synonym: *Allium longicuspis* Rege, *Porrum sativum* (L.) Rchb.

Garlic is extensively used in treating some issues such as cardiovascular diseases, arthritis, pulmonary complaints, headache, bites, abdominal growths, respiratory infections, skin disease, wounds, ulcers, tumors, aging symptoms, diarrhea, and worms (Rahman, 2007). Allicin is the compound of garlic that has antibiotic, and antibacterial properties (Mikaili *et al*., 2013). It has hypocholesterolemic, antithrombotic, antihypertensive, and antioxidative properties (Petrovska and Cekovska, 2010). (Fig: 5-B)

***Alpinia calcarata* (Haw.) Roscoe :** Synonym: *Alpinia alata* A. Dietr.

It is used to treat indigestion, vomiting, and nausea. It is also beneficial to the lungs or other pulmonary diseases. It can be used as a laxative

Table 1: List of Spices with family and scientific names, habits, and conservation status available at BAUBG

SL	Common name (Local name)	**Family** and **Scientific name**	Habit	CS
		Amaryllidaceae		
1	Onion (Peyaj)	*Allium cepa* L.	Herb	LC
2	Garlic (Rosun)	*Allium sativum* L.	Herb	LC
		Apiaceae		
3	Dill (Radhuni)	*Anethum graveolens* L.	Herb	LC
4	Coriander (Dhania)	*Coriandrum sativum* L.	Herb	LC
5	Culantro (Bilatidhonia)	*Eryngium foetidum* L.	Herb	LC
6	Fennel (Mouri)	*Foeniculum vulgare* Mill	Herb	Rare
		Bixaceae		
7	Lipstick tree (Doirang)	*Bixa orellana* L.	Herb	LC
		Lamiaceae		
8	Spearmint (Pudina)	*Mentha spicata* L.	Tree	LC
		Lauraceae		
9	Ram-tejpata	*Cinnamomum bejolghota* (Buch-Ham.) Sweet	Herb	LC
10	Indian Bay Leaf (Tejpata)	*Cinnamomum tamala* (Buch-Ham.) Nees & Eberm.	Tree	DD
11	Cinnamon (Daruchini)	*Cinnamomum verum* J. S. Presl	Tree	NE
		Leguminosae		
12	Fenugreek (Methi)	*Trigonella foenum-graecum* L.	Herb	LC
		Myristicaceae		
13	Nutmeg (Joitri & Jaifal)	*Myristica fragrans* Houtt.	Tree	LC
		Myrtaceae		
14	Allspice	*Pimenta dioica* (L.) Merr.	Tree	Rare
15	Clove (Lobongo)	*Syzygium aromaticum* (L.) Merr. & L. M. Perry	Tree	LC
		Pandanaceae		
16	Pandan (Polao Pata)	*Pandanus amaryllifolius* Roxb.	Tree	LC
		Piperaceae		
17	Betel leaf (Pan)	*Piper betle* L.	Climber	LC
18	Indian Long Pepper (Pipla)	*Piper longum* L.	Herb	Rare
19	Black Pepper (Golmorich)	*Piper nigrum* L.	Herb	LC
20	Javanese Long Pepper (Choi)	*Piper retrofractum* Vahl	Climber	LC
21	Mountain Long Pepper (Bon Pan)	*Piper sylvaticum* Roxb.	Climber	LC
		Poaceae		
22	Lemon grass	*Cymbopogon citratus*(DC.) Stapf	Climber	CD
		Ranunculaceae		
23	Black Cumin (Kalo Jira)	*Nigella sativa* L.	Herb	LC
		Rosaceae		
24	European Plum (Alu Bukhara)	*Prunus domestica* L.	Herb	LC
		Rutaceae		
25	Pan Bilash	*Clausena heptaphylla* (Roxb.) Wight &Arn.	Tree	LC
26	Curry leaf	*Murraya koenigii* (L.) Spreng.	Shrub	LC
		Solanaceae		
27	Chilli (Morich)	*Capsicum annuum* L.	Tree	LC
		Zingiberaceae		
28	Snap Ginger (ChotoAlachi)	*Alpinia calcarata*(L) Maton	Herb	LC
29	Turmeric (Holud)	*Curcuma longa* L.	Herb	LC
30	Zinger (Aada)	*Zingiber officinale* Roscoe	Herb	LC

CD= Conservation Dependent, DD= Data Deficient, LC= Least Concerned, NE= Not Evaluated

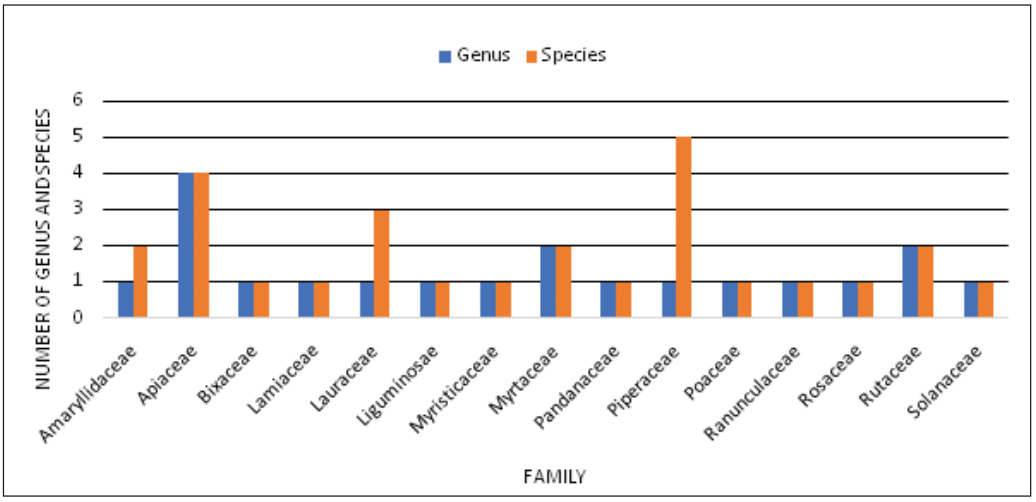

Fig. 2: Genera and species distribution of the spice crops available in BAUBG under different families.

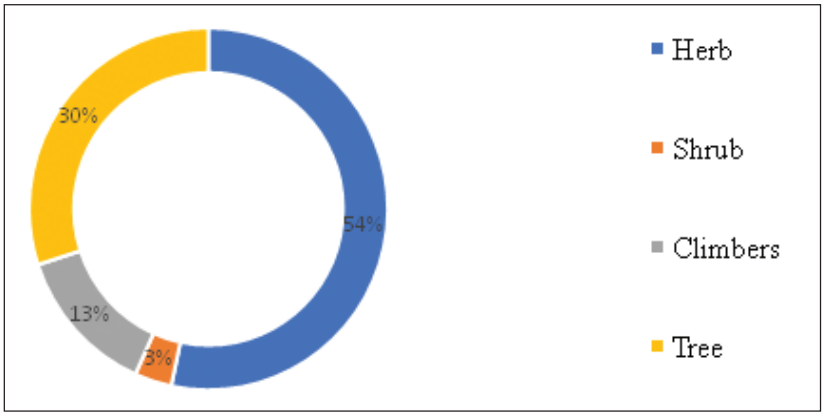

Fig. 3: Habit-wise diversity percentages of the spice cropsavailable in BAUBG.

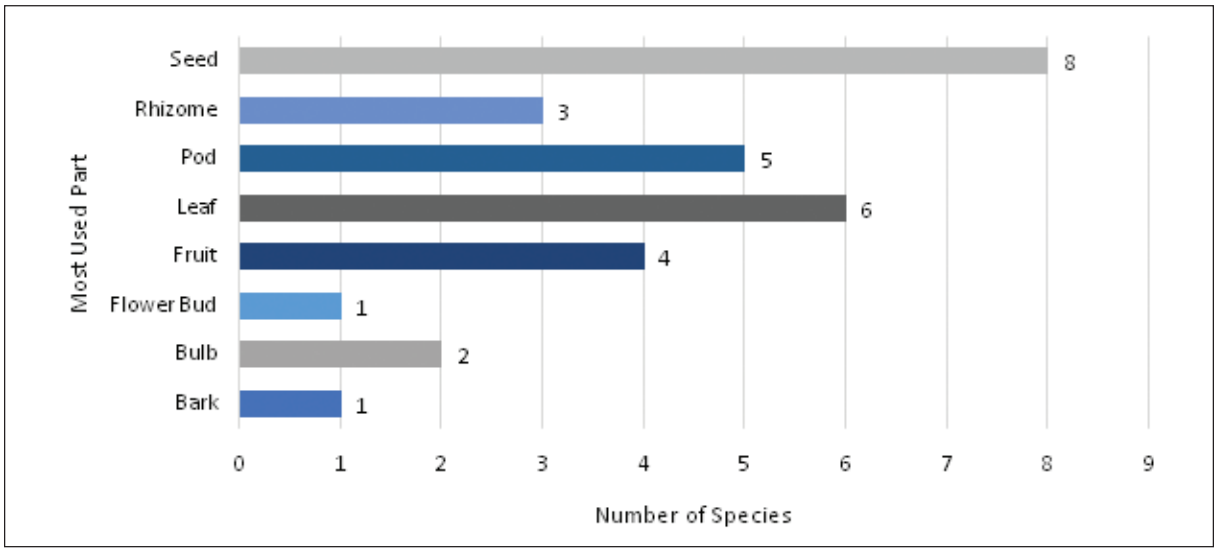

Fig. 4: Distribution of species based on the plant parts commonly used for culinary and/or medicinal purposes.

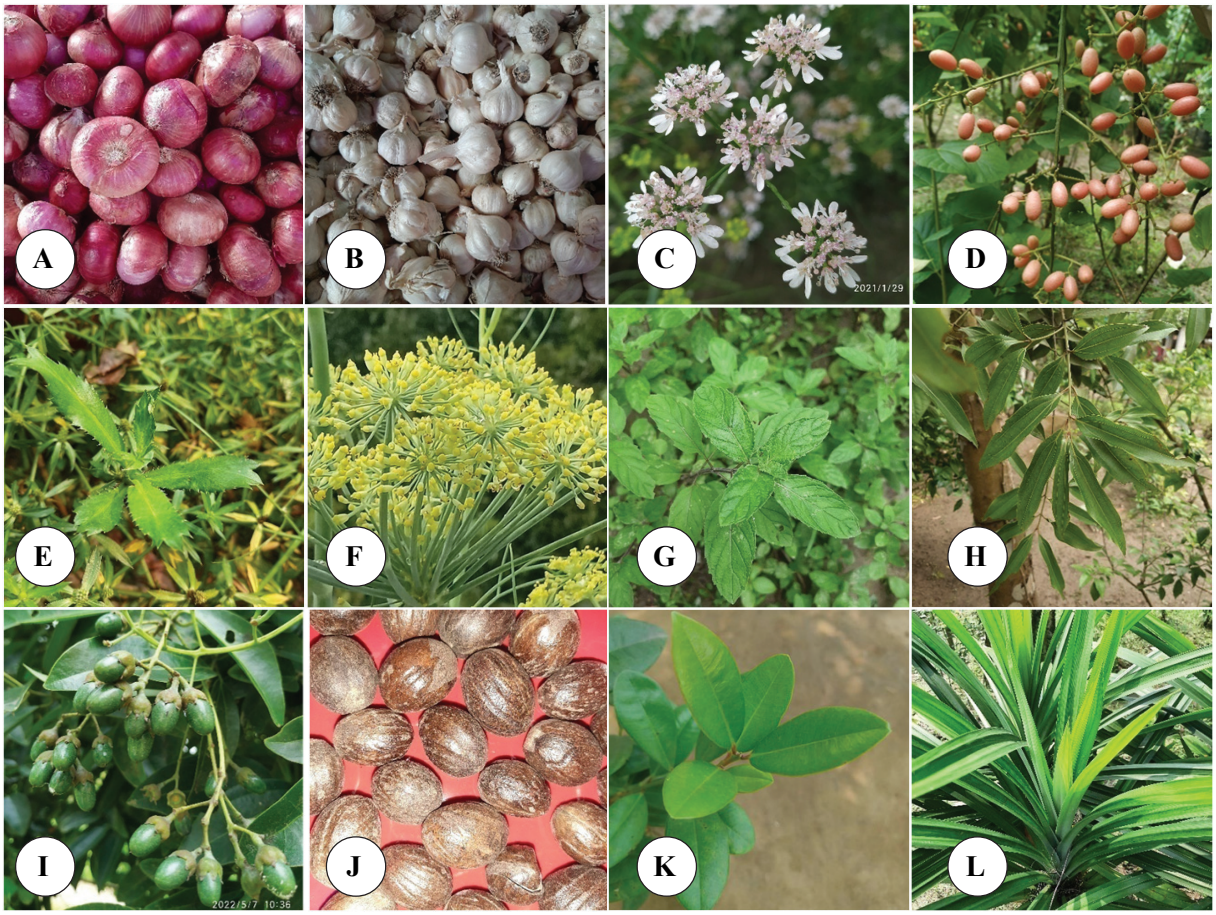

Fig. 5: A. *Allium cepa* **B.** *Allium sativum* **C.** *Coriandrum sativum* **D.** *Clausena heptaphylla* **E.** *Eryngium foetidum* **F.** *Foeniculum vulgare* **G.** *Mentha spicata* **H.** *Cinnamomum tamala* **I.** *Cinnamomum verum* **J.** *Myristica fragrans* **K.** *Pimenta dioica* **L.** *Pandanus amaryllifolius*

and it prevents stomach pain, flatulence, and gripping. (Fig. 6-K)

***Anethum graveolens*L.:** Synonym : *Anethum arvense* Salisb.

It is commonly used in Ayurvedic medicine to treat abdominal discomfort, digestion, and constipation. It also cures ulcers, abdominal pain, eye diseases, and urinal pain.

***Bixa orellana* L. :** Synonym: *Bixa americana* Poir.

The seeds have been used as laxative, cardiotonic, hypotensive, and antibiotic. It is also used as an anti-inflammatory agent for bruises and wounds as well as for the treatment of bronchitis and wound healing. Leaves are effective against bronchitis, and eye inflammation (Vilar *et al*., 2014).

***Capsicum annuum* L. :** Synonym : *Capsicum conoide* Mill.

Chilli is widely used in beverage industries, pharmaceuticals, cosmetics, and as a flavoring and coloring agent in meat processing (Rymbai *et al*., 2011). Traditionally, Chilli fruits are used for the healing of wounds and to treat cough, toothache, rheumatoid arthritis, infections, and sore throat. It has some other major properties, like anticancer, antibacterial effects, counterirritant, and antiseptic as well. Dyspepsia and flatulence can be protected by chilis (Singletary, 2011; Pawar *et al*., 2011).(Fig: 6-I).

***Cinnamomum bejolghota* (Buch-Ham.) Sweet:** Synonym : *Cinnamomum sikkimense*

Lukman.The plant extracts possess warming stimulant, astringent, digestive, carminative, blood purifier, antiseptic, antioxidant, antifungal, antiviral, antibacterial, anti-inflammatory, and immunomodulatory properties. The Plant also helps lowering cholesterol and blood sugar levels (Kumar *et al*., 2019).

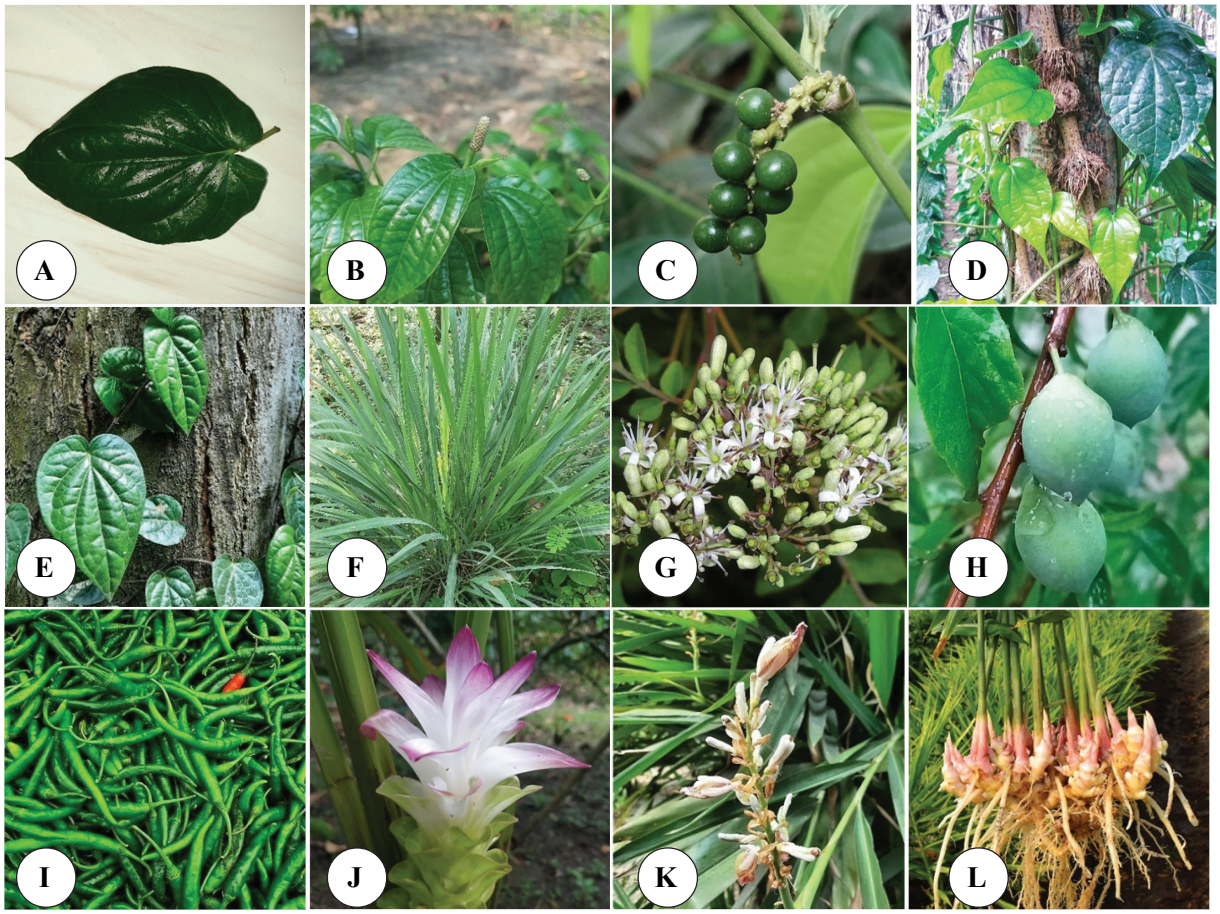

Fig. 6: A. *Piper betle* **B.***Piper longum* **C.** *Piper nigrum* **D.** *Piper retrofractum* **E.** *Piper sylvaticum* **F.** *Cymbopogon citrates* **G.** *Murraya koenigii* **H.** *Prunus domestica* **I.** *Capsicum annuum* **J.***Curcuma longa* **K.***Alpinia calcarata* **L.** *Zingiber officinale*

***Cinnamomum tamala* (Buch-Ham.) Nees & Eberm. :** Synonym: *Cinnamomum albiflorum*

Nees.Bay leaves are one of the most essential spices used in cooking and have been used as a traditional medicine to treat several diseases such as indigestion, earaches, rheumatism, and sprains, and to enhance perspiration (Fang *et al*., 2005). It has very powerful antioxidant, analgesic, and anti-inflammatory properties (Sayyah *et al*., 2003)(Fig. 5-H).

***Cinnamomum verum* J. S. Presl :** Synonym: *Camphorina cinnamomum* (L.) Farw.

Cinnamon contains a large number of essential oils and resins, mainly cinnamaldehyde, cinnamate, eugenol, and cinnamic acid. These chemical constituents of cinnamon possess anti-inflammatory, anticancer, antimicrobial, antidiabetic, and antioxidant properties. It is also used against cardiovascular diseases and neurological disorders (Manojlovic *et al*., 2012). Cinnamon is also beenused to cure dental problems in traditional medicine (Aneja *et al*., 2009; Azad *et al*., 2016)).(Fig. 5-I)

***Clausenaheptaphylla* (Roxb.) Wight & Arn. :** Synonym: *Amyris anisata* Roxb. ex Steud.

It is known to be used in paralysis, headache, muscle pain, ulcerated nose, and malarial fever. The leaf extract of this plant has great anti-bacterial properties. The bark can be used to treat cattle wounds and sprains (Fakruddin *et al*., 2012). (Fig: 5-D)

***Coriandrum sativum* L. :** Synonym: *Coriandrum globosum* Salisb.:

The primary ingredients found in Coriander are geranyl acetate, geraniol, camphor, ápinene, linalool, and ã-terpinene (Nadeem *et al.,* 2013). Traditionally, coriander is used to treat anxiety, loss of appetite, convulsion, dyspeptic complaints, and insomnia. It is used as an anti-hyperglycemic agent

and it controls blood glucose as well (Gallagher *et al.,* 2003). (Fig. 5-C)

***Curcuma longa* L. :** Synonym : *Curcuma brog* Valeton:

In traditional medicine, turmeric is used for treating rheumatism, body ache, skin problems, intestinal worms, amenorrhea, diarrhea, constipation, intermittent fevers, ulcers, arthritis, hepatic diseases, urinary discharges, dyspepsia, inflammation, leukoderma, dental diseases, dyspepsia, acidity, indigestion, flatulence, colitis and hepatitis (Ammon and Wahl, 1997).(Fig. 6-J).

***Cymbopogon citratus* (DC.) Stapf :** Synonym: *Andropogon ceriferus*Hack.

The plant is used in folk medicine as an analgesic, antiemetic, antitussive, antispasmodic, hypotensive, anticonvulsant, antirheumatic, and antiseptic, and for treating gastrointestinal and nervous disorders as well as fevers (Shah *et al.,* 2011; Premathilake *et al*., 2018). (Fig. 6-F).

***Eryngium foetidum* L. :** Synonym : *Eryngium antihystericum* Rottler.

The plant is used to treat burns, earaches, fevers, constipation, asthma, worms, snakebites, malaria, diarrhea, hypertension, infertility complication, etc. The areal parts have anthelminthic activity as well as antibacterial, and anti-inflammatory properties (Paul *et al*., 2011). (Fig. 5-E).

***Foeniculum vulgare* Mill. :** Synonym: *Anethum dulce* DC.

Fennels are widely used in treating different respiratory ailments. It can also be used to treat a wide range of digestive, reproductive, and endocrine systems and as a galactagogue agent for lactating mothers (Badgujar *et al*., 2014).(Fig. 5-F).

***Mentha spicata* L. :** Synonym : *Mentha aquatica var. crispa* (L.) Benth.

Spearmints are traditionally used to treat colds, fever, cough, asthma, jaundice, obesity, and digestive problems. Volatile oils from spearmint have efficient inhibiting properties against fungi, bacteria, and other parasites (El Menyiy, 2022; Amel *et al*., 2022). (Fig. 5-G).

***Murraya koenigii* (L.) Spreng. :** Synonym : *Bergera koenigii* L.

Curry leaves have stimulating properties and are used to treat common body aches. It is also used in treating edema, fresh cuts, inflammation, itching, bruises, dysentery, and piles (Balakrishnan, 2020).(Fig. 6-G)

***Myristica fragrans* Houtt. :** Synonym : *Aruana silvestris* Burm.f.

Nutmeg possesses antioxidant, immunomodulatory, and radio-protective activities due to the presence of â caryophyllene, eugenol, and lignans (Naeem *et al*., 2016). It shows a strong antibiotic property against bacteria and fungi as well (Dorman and Deans, 2004).(Fig. 5-J).

***Nigella sativa* L. :** Synonym : *Nigella cretica* Mill.

Black cumin is effectively used to treat jaundice, coughs, tumors, rhinitis, cataracts, alopecia, tertian fever, migraine, rheumatism, headache, paralysis, abdominal disorders, hydrophobia, orchitis, ulcers, vitiligo. (Kunnumakkara *et al.,* 2009).

***Pandanus amaryllifolius*Roxb. :** Synonym: *Pandanus hasskarlii* Merr.

Pandan is high in vitamins, minerals, and antioxidants, which it is widely used to treat health issues like headaches, earaches, and arthritis. It also reduces atherosclerosis formation, heals burns, and controls blood sugar (Keim *et al.,* 2020). (Fig: 5-L)

***Pimenta dioica* (L.) Merr. :** Synonym: *Pimenta officinalis* Lindl.

The plant has hypotensive, antibacterial, anti-neuralgic, antiproliferative, anti-tumor and analgesic properties. Crushed allspices are used to treat sore joints and muscle aches (Myalgia). It is also used to relieve respiratory congestion and toothache (Zhang &Lokeshwar, 2012).

***Piper betle* L. :** Synonym: *Betela mastica* Raf.

Betel leaves are widely used for chewing purposes but they possess various health benefits. It has analgesic properties that instant relief from pain, ease constipation, improve digestion, reduce respiratory issues, maintain oral health, relieve joint pain, manage diabetes, and so on (Rai *et al*., 2019)(Fig. 6-A).

***Piper longum* L. :** Synonym : *Chavica longa* H. Karst.

It is commonly used to treat asthma, bronchitis, respiratory infections, constipation, cholera, diarrhea, chronic malaria, and stomachache. It can be used to treat gonorrhea, paralysis of the tongue, viral hepatitis, and so on (Kumar *et al*., 2011). (Fig. 6-B)

***Piper nigrum* L. :** Synonym : *Piper aromaticum* Lam.

Black pepper is widely applied as spice and seasoning due to having beneficial health effects. This plant has been used as a chemo-preventive, anti-thyroid, thermogenic action, andanti-inflammatory as well as growth stimulator (Panda and Kar, 2003). The plant has been used for the treatment of large intestinal toxins indigestion, gastric acidity, and diarrhea. It is effective against disorders like asthma, fever, and cold (Parganiha *et al.,* 2011).(Fig. 6-C)

***Piper retrofractum* Vahl :** Synonym : *Piper chaba* Hunter

It can be used as a stimulant and also used to treat fever, asthma, hemorrhoids, bronchitis, liver ailments, jaundice, edema, and abdominal pain. Its root and fruits are useful in treating ingestion, poisoning, and anorexia (Salleh *et al*., 2020). (Fig. 6-D)

***Piper sylvaticum* Roxb. :** Synonym : *Piper malmoris* Wall.

The plant is used to treat the common cold, asthma, cough, headaches, wounds, indigestion, rheumatic pain, tuberculosis, etc. Mashed leaves can be used as an anti-inflammatory agent (Adnan *et al*., 2020)(Fig. 6-E).

***Prunus domestica* L. :** Synonym : *Druparia prunus* Clairv.

Plum fruits are used as febrifuge, stomachic, and laxative. It is also used to treat constipation. Prussic acid produced by this plant substance is poisonous which stimulates respiration and improves digestion (Zhebentyayeva *et al*., 2019)(Fig. 6-H).

***Syzygium aromaticum* (L.) Merr. & L. M. Perry :** Synonym : *Caryophyllus aromaticus* L.

Clove is used to treat sore throats, headaches, asthma as well as the digestive system, respiratory, and dental disorders (Lee *et al*., 2009) and it has a huge application in diarrhea, dyspepsia, and gastritis (Singh *et al*., 2012). (Fig. 5-K)

***Trigonella foenum-graecum* L. :** Synonym : *Trigonella tibetana* (Alef.) Vassilcz.

Fenugreek has been used to treat respiratory infections like bronchitis and pneumonia. It has hypoglycemic, hypolipidemic, and anti-hypertensive activities. Fenugreeks are used to treat reproductive disorders, treat hormonal disorders, and reduce menstrual pain (Mandal & Mandal, 2016).

***Zingiber officinale* Roscoe :** Synonym: *Amomum zingiber* L.

Ginger has been widely used to treat ailments like arthritis, cramps, fever, and helminthiasis, rheumatism, muscular aches, pains, sore throats, sprains (Dissanayake *et al*., 2020). It is also used to treat nausea, morning vomiting, colic, heartburn, flatulence, diarrhea, loss of appetite, sore stomach, gas, bloating, and dyspepsia (Prasad and Tyagi, 2015). (Fig. 6-L)

CONCLUSION

In the Indian subcontinent including Bangladesh people commonly use different parts of spices crops for culinary purposes to enhance the palatability or storage quality of foods and feeds. The spice crops possess some bioactive compounds to impart therapeutic/medicinal propertieslike antimicrobial, antioxidant, anti-inflammatory, anti-carcinogenic, cardio-tonic, and so on narrated in the text. This is a baseline work on spice crop diversity at BAUBG and its therapeutic uses for the scientific community.

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