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Examination of total polyphenol and flavonoid composition of some commonly available plants and seeds from India

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ABSTRACT

Total polyphenol (TPh) and flavonoid (Fla) contents of some commonly available plants and seeds derived from Central India were investigated spectrophotometrically using Folin-Ciocalteu and aluminum chloride as reagents. The TPh and Fla contents of tree barks (73), leaves (62), flowers (40), seed pods (11), seed coats (37), and seeds (227) were evaluated in the following ranges (unit g 100 g^{-1}): 0.15-5.30 and 0.11-4.2 for tree barks, 1.25-4.13 and 1.04-3.76 for leaves, 1.75-18.69 and 1.27-18.20 for flowers, 0.94-2.88 and 0.21-1.74 for seed pods, 0.18-5.11 and 0.10-4.23 for seed coats, and 0.01-5.00 and 0.01-4.47 for seeds. The concentrations of TPh and Fla were investigated in detail and cluster analysis was used to study the differential distributions. Polyphenol data sets of 450 plants as food supplement and nutrition sources were obtained.

KEYWORDS: total polyphenols, flavonoids, barks, leaves, flowers, seeds.

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1. INTRODUCTION

Antioxidants found in plants can be classified into three primary groups: carotenoids, allyl sulfites, and polyphenols. The latter are secondary metabolites of plants and are generally involved in defense mechanisms against environmental threats and aggression by pathogens. More than 8,000 types of polyphenols have been identified, and can be further categorized into 4 main groups, i.e. flavonoids (flavanones, isoflavones, anthocyanins, flavanols, flavanols, flavones, neoflavanoids and chalcones), stilbenes (resveratrol and pterostilbene), lignans (podophyllotoxin, arctigenin and tracheologin) and phenolic acids (protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, caffeic acid, p-coumaric acid, ferulic acid, syringic acid, sinapinic acid, etc.) according to Mustafa *et al.* [1].

Polyphenol-rich foods and polyphenols are receiving increasing attention due to their potential beneficial effects toward human health, thanks to their anti-inflammatory and antioxidant properties [2]. Various plant parts (root, bark, leaf, flower, seed, seed coat, seed pod, etc.) rich in polyphenols and flavonoids are finding relevant applications not only to treat diseases [3], such as neurodegenerative diseases, cancers, inflammation, cardiovascular health, type-II diabetes, or obesity, but also in insect control, as antibacterial agents, in food processing, and in the production of functional foods [4].

Significant research efforts are being devoted to the phytochemical screening and evaluation of polyphenols and flavonoids in plants from various countries. In the case of Central India, potentially rich polyphenol substrates have been identified [5-12], but analyses of larger datasets are necessary, given that a growing adult population living in developing countries is not consuming an adequate amount of dietary polyphenols. Hence, in this work, total polyphenol (TPh) and flavonoid (Fla) contents in 450 commonly available plant samples were investigated, covering barks, leaves, flowers, seed pods, seed coats, and seeds. Cluster analysis and correlation coefficients were used for data analysis.

2. MATERIALS AND METHODS

2.1. Sample collection and processing

Plant samples were collected from different locations in Raipur city, Chhattisgarh, India (21.25°N 81.63°E) in 2017. They were mixed to form composite samples, and initially sundried for one week in a glass room. The seeds were manually separated from seed pods and seed coats, and all samples were further dried in an oven for 24 h at 50 ºC. Their weights were measured using a Mettler-Toledo (Columbus, OH, USA) electronic precision balance. The moisture content was evaluated by drying the samples at 105 ºC in an air oven for 6 h prior to the analysis, and mean values were determined. All characterization results are presented on a dry weight basis. The dried samples were crushed into fine powder using a mortar, particles >100 μm size were sieved out, and the resulting powder was preserved in a refrigerator at -4 ºC till the analyses were conducted.

2.2. Analyses

For the spectrophotometric analysis of polyphenols, 0.10 g of processed sample was first equilibrated in an acetone:water mixture (7:3, v/v), according to the procedure described by Bertaud *et al*. [13]. To analyze the TPh content, an aliquot of the extract was reacted with Folin-Ciocalteu reagent (Sigma-Aldrich, F9252) to develop a blue colored complex [14]. Absorbance was measured at 740 nm in a UV-1800 (Shimadzu, Kyoto, Japan) UV-VIS spectrophotometer. The concentration of TPh was evaluated by preparing a standard calibration curve with gallic acid (Sigma-Aldrich, 27645-250G-R), and expressed in gallic acid equivalents (GAE). The Fla content was determined by reacting an aliquot of the extract with aluminum chloride to form a yellow-colored complex [15]. Its concentration was evaluated at 410 nm by using a quercetin (Sigma-Aldrich, Q4951-10G) standard calibration curve, and indicated in terms of quercetin equivalents (QE). Three replicates for each solvent extract were performed, and results are presented as average values across the three replicates.

2.3. Statistical analysis

Pearson’s correlation was computed by using SPSS program to study relationships between TPh and Fla values. Hierarchical cluster analysis (HCA) was carried out for the classification and differentiation of the plant samples, according to Vallverdú-Queralt *et al*. [16].

3. RESULTS AND DISCUSSION

Total polyphenol and flavonoid contents in tree bark, leaf, flower, seed pod, seed coat, and seed samples are presented in Tables 1-5 and Table S1. An itemized analysis for each of these plant parts is presented below.

The variations in polyphenol composition with respect to plant type and family are shown in Figures S1(A-G) and Figure 1. Polyphenol variability in plant depends upon the biological activities, environmental factors and nature. Among them, the most frequently occurring polyphenols are flavonoids, and variation of TPh and Fla with their ratio in the present investigation is shown in Figure S1(A). The TPh, Fla and [Fla]/[TPh] values in the 450 samples were in the following ranges: 1.096-5.964 mg 100 g^{-1}, 0.547-5.047 mg 100 g^{-1} and 0.324-0.822 mg 100 g^{-1}, respectively, with the maximum values for the flowers followed by the leaves.

Table 1. Polyphenol characteristics of bark samples, g/100 g.

Species	Family	Concentration		Fla/TPh
		TPh	Fla	
Buchanania lanzan Spreng.	Anacardiaceae	1.37±0.03	1.30±0.04	0.95
Mangifera indica L.	Anacardiaceae	5.10±0.11	4.20±0.09	0.82
Semecarpus anacardium L.f.	Anacardiaceae	3.30±0.10	2.60±0.06	0.79
Annona squamosa L.	Annonaceae	1.32±0.03	0.66±0.02	0.50
Annona reticulata L.	Annonaceae	0.80±0.02	0.35±0.01	0.44
Allamanda cathartica L.	Apocynaceae	0.99±0.02	0.27±0.01	0.27
Alstonia scholaris (L.) R.Br.	Apocynaceae	0.86±0.02	0.26±0.01	0.30
Trachelospermum jasminoides Lem.	Apocynaceae	0.89±0.02	0.35±0.01	0.39
Syagrus romanzoffiana (Cham.) Glassman	Arecaceae	0.60±0.01	0.21±0.01	0.35
Millingtonia hortensis L.f.	Bignoniaceae	2.39±0.05	0.42±0.01	0.18
Spathodea campanulata P.Beauv.	Bignoniaceae	0.32±0.01	0.12±0.01	0.38
Bombax ceiba L.	Bombaceae	0.16±0.01	0.12±0.01	0.75
Cordia dichotoma G.Forst.	Borangiaceae	1.45±0.03	0.20±0.01	0.14
Anogeissus latifolia (Roxb. ex DC.) Bedd.	Combretaceae	1.93±0.04	0.54±0.01	0.28
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Combretaceae	2.47±0.06	0.89±0.02	0.36
Terminalia bellerica Roxb.	Combretaceae	0.23±0.01	0.14±0.01	0.61
Terminalia chebula Retz. Retz.	Combretaceae	0.23±0.01	0.12±0.01	0.52
Shorea robusta C.F.Gaertn.	Dipterocarpaceae	0.16±0.01	0.16±0.01	1.00
Diospyros melanoxylon Roxb.	Ebenaceae	0.15±0.01	0.14±0.01	0.93
Pterocarpus marsupium Roxb.	Euphorbiaceae	0.23±0.01	0.14±0.01	0.61
Acacia auriculiformis Benth.	Fabaceae	2.08±0.05	1.03±0.02	0.50
Acacia catechu (L.f.) Willd.	Fabaceae	0.29±0.01	0.12±0.01	0.41
Acacia concinna (Willd.) DC.	Fabaceae	1.47±0.03	0.14±0.01	0.10
Acacia sieberiana DC.	Fabaceae	1.57±0.03	0.51±0.01	0.32
Acacia nilotica Schumach. & Thonn.	Fabaceae	1.95±0.04	0.52±0.01	0.27
Albizia saman (Jacq.) Merr.	Fabaceae	1.38±0.03	1.22±0.03	0.88
Albizia lebbeck (L.) Benth.	Fabaceae	1.98±0.04	0.30±0.01	0.15
Albizia odoratissima (L.f.) Benth.	Fabaceae	0.50±0.01	0.15±0.01	0.30
Bauhinia purpurea L.	Fabaceae	0.62±0.01	0.11±0.01	0.18
Bauhinia racemosa Lam.	Fabaceae	0.68±0.02	0.16±0.01	0.24
Butea frondosa Roxb.	Fabaceae	0.23±0.01	0.15±0.01	0.65
Cassia fistula L.	Fabaceae	2.10±0.05	1.57±0.03	0.75

Table 1 continued..

Species	Family	Concentration		Fla/TPh
		TPh	Fla	
Dalbergia sissoo DC.	Fabaceae	1.10±0.02	0.75±0.02	0.68
Delonix regia (Bojer) Raf.	Fabaceae	0.95±0.02	0.21±0.01	0.22
Leucaena leucocephala (Lam.) de Wit	Fabaceae	0.44±0.01	0.11±0.01	0.25
Peltophorum pterocarpum (DC.) Backer ex K.Heyne	Fabaceae	3.13±0.07	2.54±0.05	0.81
Pithecollobium dulce (Roxb.) Benth.	Fabaceae	2.14±0.05	1.43±0.03	0.67
Prosopis juliflora (Sw.) DC.	Fabaceae	1.61±0.04	0.61±0.01	0.38
Pongamia pinnata (L.) Pierre	Fabaceae	2.19±0.05	1.09±0.02	0.50
Saraca asoca (Roxb.) Willd.	Fabaceae	0.30±0.02	0.28±0.01	0.93
Tamarindus indica L.	Fabaceae	0.34±0.02	0.21±0.01	0.62
Gmelina arborea Roxb. ex Sm.	Lamiaceae	0.29±0.01	0.14±0.01	0.48
Careya arborea Roxb.	Lecythidaceae	0.68±0.02	0.12±0.01	0.18
Lagerstroemia parviflora Roxb.	Lythraceae	1.99±0.04	0.55±0.01	0.28
Lawsonia inermis L.	Lythraceae	2.25±0.05	0.15±0.01	0.07
Punica granatum L.	Lythraceae	3.72±0.08	3.23±0.07	0.87
Azadirachta indica A.Juss.	Meliaceae	0.58±0.01	0.17±0.01	0.29
Melia azadirachta L.	Meliaceae	0.82±0.02	0.18±0.01	0.22
Azadirachta indica A.Juss.	Meliaceae	0.37±0.01	0.14±0.01	0.38
Melia dubia Cav.	Meliaceae	0.40±0.01	0.30±0.01	0.75
Artocarpus heterophyllus Lam.	Moraceae	0.79±0.01	0.74±0.02	0.94
Ficus benghalensis L.	Moraceae	0.47±0.01	0.26±0.01	0.55
Ficus religiosa L.	Moraceae	0.45±0.01	0.24±0.01	0.53
Ficus glomerata Roxb.	Moraceae	0.44±0.01	0.34±0.01	0.77
Moringa oleifera Lam.	Moringaceae	5.30±0.12	2.00±0.04	0.38
Psidium guajava L.	Myrtaceae	2.29±0.05	0.77±0.02	0.34
Eucalyptus grandis W.Hill ex Maiden	Myrtaceae	1.43±0.04	1.20±0.03	0.84
Eugenia jambolana Lam.	Myrtaceae	0.17±0.01	0.16±0.01	0.94
Nyctanthes arbor-tristis L.	Oleaceae	0.20±0.01	0.18±0.01	0.90
Bridelia retusa A.Juss.	Phyllanthaceae	0.20±0.01	0.18±0.01	0.90
Cleistanthus collinus (Roxb.) Hook.f.	Phyllanthaceae	0.20±0.01	0.18±0.01	0.90
Phyllanthus emblica L.	Phyllanthaceae	0.20±0.01	0.18±0.01	0.90
Ziziphus mauritiana Lam.	Rhamnaceae	0.20±0.01	0.18±0.01	0.90
Neolamarckia cadamba (Roxb.) Bosser	Rubiaceae	0.20±0.01	0.18±0.01	0.90

Table 1 continued..

Species	Family	Concentration		Fla/TPh
		TPh	Fla	
Gardenia jasminoides Ellis	Rubiaceae	0.20±0.01	0.18±0.01	0.90
Mitragyna parvifolia Korth.	Rubiaceae	0.20±0.01	0.18±0.01	0.90
Aegle marmelos Corrêa	Rutaceae	0.20±0.01	0.18±0.01	0.90
Murraya koenigii Spreng.	Rutaceae	0.20±0.01	0.18±0.01	0.90
Sapindus emarginatus Vahl.	Sapindaceae	0.23±0.01	0.13±0.01	0.57
Madhuca indica J.F.Gmel.	Sapotaceae	0.46±0.01	0.31±0.01	0.67
Mimusops elengi L.	Sapotaceae	2.21±0.06	0.17±0.01	0.08
Simarouba glauca DC.	Simaroubaceae	0.51±0.02	0.29±0.01	0.57
Tectona grandis L.f.	Verbenaceae	0.18±0.01	0.11±0.01	0.61

Table 2. Polyphenol characteristics of plant leaves, g/100 g.

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Amaranthus dubius Mart.	Amaranthaceae	H	2.02±0.05	1.63±0.04	0.81
Mangifera indica L.	Anacardiaceae	T	4.13±0.08	3.76±0.05	0.91
Semecarpus anacardium L.f.	Anacardiaceae	T	3.31±0.07	1.20±0.03	0.36
Annona reticulata L.	Annonaceae	T	2.49±0.05	2.22±0.04	0.89
Annona squamosa L.	Annonaceae	S	2.88±0.06	1.93±0.04	0.67
Coriandrum sativum L.	Apiaceae	H	3.36±0.10	2.97±0.06	0.88
Peltandra virginica Schott	Araceae	H	2.46±0.06	1.82±0.04	0.74
Helianthus annuus L.	Asteraceae	H	2.68±0.06	1.71±0.04	0.64
Brassica campestris L.	Brassicaceae	H	3.10±0.09	1.92±0.04	0.62
Cordia dichotoma G.Forst.	Borangiaceae	T	3.88±0.08	3.14±0.08	0.81
Spathodea campanulata P.Beauv.	Borangiaceae	T	2.76±0.06	1.06±0.03	0.38
Terminalia catappa L.	Combretaceae	T	2.99±0.06	1.12±0.03	0.37
Terminalia chebula Retz.	Combretaceae	T	3.31±0.10	2.32±0.05	0.70
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Combretaceae	T	3.06±0.09	2.59±0.07	0.85
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	T	2.39±0.05	2.02±0.04	0.85
Momordica charantia L.	Cucurbitaceae	V	2.57±0.06	1.04±0.03	0.40
Jatropha curcas L.	Euphorbiaceae	S	2.25±0.06	1.65±0.03	0.73

Table 2 continued..

Species	**Family**	**Type**	**Concentration**		**Fla/TPh**
			TPh	**Fla**	
Albizia odoratissima (L.f.) Benth.	Fabaceae	T	1.61±0.03	1.24±0.03	0.77
Pterocarpus marsupium Roxb.	Fabaceae	T	2.78±0.06	1.78±0.04	0.64
Lathyrus sativus L.	Fabaceae	H	3.10±0.09	2.10±0.05	0.68
Arachis hypogaea L.	Fabaceae	H	2.46±0.06	1.59±0.03	0.65
Tephrosia purpurea (L.) Pers.	Fabaceae	H	2.57±0.05	1.57±0.03	0.61
Cassia tora L.	Fabaceae	H	2.78±0.06	1.96±0.04	0.71
Acacia catechu (L.f.) Willd.	Fabaceae	S	3.33±0.10	2.54±0.06	0.76
Acacia concinna (Willd.) DC.	Fabaceae	S	2.50±0.06	1.18±0.03	0.47
Acacia nilotica Schumach. & Thonn.	Fabaceae	S	2.80±0.07	1.75±0.04	0.63
Butea frondosa Roxb.	Fabaceae	S	2.54±0.06	1.24±0.06	0.49
Dalbergia sissoo DC.	Fabaceae	T	3.74±0.10	3.14±0.09	0.84
Pongamia pinnata (L.) Pierre	Fabaceae	T	1.25±0.04	2.15±0.05	1.72
Saraca indica L.	Fabaceae	T	2.89±0.09	2.29±0.05	0.79
Trigonella foenum-graecum L.	Fabaceae	H	1.56±0.05	2.03±0.05	1.30
Hyptis suaveolens (L.) Poit.	Lamiaceae	H	3.21±0.10	3.10±0.09	0.97
Ocimum sanctum L.	Lamiaceae	W	2.89±0.08	1.89±0.05	0.65
Origanum vulgare L.	Lamiaceae	H	2.99±0.09	2.98±0.06	1.00
Litsea glutinosa (Lour.) C.B.Rob.	Lauraceae	T	2.68±0.06	1.72±0.04	0.64
Linum usitatissimum L.	Linaceae	H	2.14±0.05	2.01±0.04	0.94
Lagerstroemia parviflora Roxb.	Lythraceae	T	2.14±0.04	2.02±0.04	0.94
Lawsonia inermis L.	Lythraceae	T	3.08±0.11	2.48±0.05	0.81
Malachra capitata L.	Malvaceae	H	2.46±0.05	1.73±0.03	0.70
Hibiscus sabdariffa L.	Malvaceae	H	1.93±0.04	1.74±0.04	0.90
Gossypium arboreum L.	Malvaceae	S	2.68±0.05	1.83±0.04	0.68
Thespesia populnea Sol. ex Corrêa	Malvaceae	T	2.57±0.05	1.57±0.03	0.61
Abelmoschus esculentus Moench	Malvaceae	H	2.89±0.06	2.04±0.04	0.71
Melia azadirachta L.	Meliaceae	T	3.96±0.08	1.38±0.03	0.35
Artocarpus heterophyllus Lam.	Moraceae	T	2.08±0.04	1.78±0.05	0.86
Ficus racemosa L.	Moraceae	S	2.73±0.06	1.97±0.05	0.72
Ficus religiosa L.	Moraceae	T	3.01±0.0.11	2.64±0.07	0.88
Moringa oleifera Lam.	Moringaceae	T	3.56±0.10	1.71±0.04	0.48
Eucalyptus grandis W.Hill ex Maiden	Myrtaceae	T	2.96±0.07	2.92±0.06	0.99

Table 2 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Eugenia jambolana Lam.	Myrtaceae	T	2.08±0.04	1.26±0.03	0.61
Psidium guajava L.	Myrtaceae	S	3.45±0.08	2.31±0.05	0.67
Nyctanthes arbor-tristis L.	Oleaceae	T	3.04±0.07	2.04±0.05	0.67
Phyllanthus emblica L.	Phyllanthaceae	T	1.28±0.03	1.19±0.03	0.93
Ziziphus mauritiana Lam.	Rhamnaceae	S	3.21±0.09	2.53±0.06	0.79
Murraya koenigii Spreng.	Rutaceae	S	2.68±0.04	1.64±0.04	0.61
Citrus lemon	Rutaceae	S	2.51±0.06	1.63±0.04	0.65
Sapindus emarginatus Vahl.	Sapindaceae	T	2.95±0.07	1.15±0.03	0.39
Simarouba glauca DC.	Simaroubaceae	T	2.61±0.05	1.23±0.04	0.47
Manilkara zapota (L.) P.Royen	Sapotaceae	T	2.65±0.06	1.75±0.04	0.66
Mimusoups elengi	Sapotaceae	T	2.91±0.06	1.61±0.04	0.55
Solanum lycopersicum L.	Solanaceae	V	2.78±0.06	1.96±0.05	0.71
Lantana camara L.	Verbenaceae	H	1.39±0.04	1.18±0.03	0.85

T = tree, S = shrub, H = herb, V = vine.

Table 3. Polyphenol characteristics of flowers, g/100 g.

Species	Family	Color	Concentration		Fla/TPh
			TPh	Fla	
Begonia sp.	Begoniaceae	R	2.47±0.05	2.22±0.04	0.90
Begonia sp.	Begoniaceae	W	5.85±0.12	5.27±0.11	1.00
Chrysanthemum sp.	Asteraceae	W	2.78±0.06	2.29±0.05	0.82
Chrysanthemum sp.	Asteraceae	Y	2.79±0.07	1.59±0.03	0.57
Chrysanthemum sp.	Asteraceae	P	3.72±0.08	3.54±0.07	0.95
Chrysanthemum sp.	Asteraceae	Y	2.96±0.07	2.42±0.05	0.82
Chrysanthemum sp.	Asteraceae	M	4.08±0.08	3.60±0.07	0.88
Chrysanthemum sp.	Asteraceae	PWS	1.75±0.04	1.68±0.04	0.96
Dahlia sp.	Asteraceae	ShPe	10.67±0.22	10.38±0.21	0.97
Dahlia sp.	Asteraceae	SY	8.65±0.18	7.42±0.16	0.86
Dahlia sp.	Asteraceae	OY	10.73±0.23	10.49±0.21	0.98
Dahlia sp.	Asteraceae	Pi	5.34±0.11	3.42±0.07	0.64
Dahlia hybrida	Asteraceae	PaPP	6.05±0.12	5.47±0.12	0.90

Table 3 continued..

Species	Family	Color	Concentration		Fla/TPh
			TPh	Fla	
Dahlia sp.	Asteraceae	R	15.82±0.31	14.68±0.30	0.93
Dahlia sp.	Asteraceae	W	4.31±0.08	4.10±0.08	0.95
Dahlia 'happy days'	Asteraceae	P	5.70±0.12	3.38±0.07	0.59
Dahlia sp.	Asteraceae	PW	4.64±0.10	1.90±0.04	0.41
Dahlia sp.	Asteraceae	RW	5.69±0.13	5.56±0.14	0.98
Gaillardia sp.	Asteraceae	W	5.63±0.12	4.23±0.09	0.75
Gaillardia sp.	Asteraceae	Y	4.16±0.08	4.03±0.09	0.97
Hibiscus sp.	Malvaceae	RYPe	2.57±0.05	1.27±0.03	0.49
Hibiscus rosa-sinensis L.	Malvaceae	R	4.54±0.09	1.93±0.04	0.42
Hibiscus sp.	Malvaceae	DPi	6.45±0.12	3.52±0.08	0.55
Hibiscus sp.	Malvaceae	LPi	4.95±0.10	2.32±0.05	0.47
Hibiscus sp.	Malvaceae	Pi	5.93±0.11	1.48±0.04	0.25
Lychnis chalcedonica L.	Caryophyllaceae	DR	3.50±0.07	3.13±0.06	0.89
Nerium indicum Mill.	Apocynaceae	R	2.87±0.05	2.78±.06	0.97
Rosa ×kordesii H.Wulff	Rosaceae	R	2.66±0.05	2.51±0.04	0.94
Rosa 'Jacare'	Rosaceae	DWC	3.59±0.07	3.43±0.08	0.95
Rosa hybrid	Rosaceae	DR	2.65±0.06	2.50±0.05	0.94
Rosa hybrid	Rosaceae	DDY	3.37±0.07	3.02±0.06	0.90
Rosa 'Macha'	Rosaceae	DCWRPi	2.33±0.05	1.82±0.04	0.78
Rosa 'Jacum'	Rosaceae	DRP	3.66±0.07	3.52±0.07	0.96
Rosa 'Angel'	Rosaceae	DP	3.33±0.05	3.25±0.05	0.98
Tagetes erecta L.	Asteraceae	Y	18.69±0.37	18.20±0.36	0.97
Tagetes erecta L.	Asteraceae	DO	10.70±0.22	10.41±0.21	0.97
Tagetes erecta L.	Asteraceae	SYM	8.00±0.16	7.48±0.15	0.94
Tagetes erecta L.	Asteraceae	AMO	10.04±0.21	9.49±0.20	0.95
Tagetes erecta L.	Asteraceae	DY	12.26±0.25	10.68±0.22	0.87
Tagetes erecta L.	Asteraceae	IY	12.69±0.26	10.88±0.21	0.86

RYP = Reddish yellow peach, Y = Yellow, W = White, R = Red, DR = Dark red, P = Pink, PWS = Pink-white shaded, M = Maroon, P = Purple.

High TPh contents in barks were associated with three families: Anacardiaceae, Lythraceae and Moringaceae, as shown in Figure S1(B). The TPh contents in the leaves was poorly correlated with the leaf mass (r = 0.37) and moisture contents (r = -0.39). No significant differences in the polyphenol contents in the leaves as a function of the type of plant were detected (Figure S1(C)).

Table 4. Polyphenol characteristics of seed pods, g/100 g.

Species	Family	Concentration		Fla/TPh
		TPh	Fla	
Acacia nilotica Schumach. & Thonn.	Fabaceae	2.88±0.06	0.50±0.01	0.17
Albizia lebbeck (L.) Benth.	Fabaceae	0.94±0.02	0.39±0.01	0.41
Albizia saman (Jacq.) Merr.	Fabaceae	1.93±0.04	1.11±0.03	0.58
Bauhinia purpurea L.	Fabaceae	2.60±0.05	0.45±0.01	0.17
Cassia fistula L.	Fabaceae	2.32±0.05	0.71±0.02	0.31
Delonix regia (Bojer) Raf.	Fabaceae	2.30±0.05	0.35±0.01	0.15
Leucaena leucocephala (Lam.) de Wit	Fabaceae	2.15±0.04	1.74±0.04	0.81
Pithecollobium dulce (Roxb.) Benth.	Fabaceae	2.45±0.05	0.85±0.02	0.35
Pongamia pinnata (L.) Pierre	Fabaceae	1.64±0.03	0.21±0.01	0.13
Lawsonia inermis L.	Lythraceae	2.53±0.05	0.79±0.02	0.31
Sapindus emarginatus Vahl.	Sapindiaceae	2.30±0.05	0.40±0.01	0.17

Nonetheless, large variations were detected depending on the plant family, as shown in Figure S1(D) with TPh contents ranging from 1.28 (Phyllanthaceae) to 3.96 (Meliaceae). It is worth noting that no trends for Fla were observed. In the case of the flavonoid contents, Fla/TPh ratios ranged from 0.35 to 1.00.

The bright and deep colored flowers (Table 3) exhibited the highest TPh values. The maximum content was detected in flowers of Asteraceae family (Figure S1(E)), especially in those from African marigold (*Tagetes erecta*). Regarding the Fla/TPh ratios, although they varied from 0.3 to 1, the mean value was high (0.82).

Despite the fact that the highest TPh values in the pods were found in *Acacia nilotica* and *Bauhinia purpurea*, which belong to the Fabaceae family, on average, relatively higher polyphenol contents were found in pods from the Lythraceae family (Figure S1(F)). Large variations in the polyphenol content in the seed coats were observed as a function of plant types, with noticeably higher TPh and Fla values in seed coats from tree species (Figure S1(C)). Remarkable differences in the polyphenol content of the seed coat samples as a function of the family were also detected (Figure S1(G)): Combretaceae, Nelumbonaceae, Phyllanthaceae and Rutaceae families showed the highest TPh contents, while Combretaceae, Rutaceae and Lamiaceae families showed the highest Fla contents. Specifically, the highest TPh and Fla contents were found in the seed coats from *Terminalia chebula* and *Terminalia arjuna*.

The TPh and Fla values largely depended on plant type, following the sequence: shrubs > trees > herbs > vines (Figure S1(C)). Large variations were also detected as a function of the family, in such a way that the highest values were recorded for seeds from Dipterocarpaceae, Ebenaceae, Meliaceae, Papeveraceae, Passifloraceae, Pedaliaceae and Ranunculaceae families (Figure 1).

The cluster analysis based on the TPh contents of samples from the different plant parts under study (i.e., bark, seed coat, leaf, and seed samples) are shown in Figure S2 (A-F). Seed pods were excluded from the analysis, given the small number of samples. Two species were clearly differentiated as the richest in polyphenols in the case of bark samples (*Mangifera indica* and *Moringa oleifera*), seed coat samples (*Terminalia chebula* and *T. arjuna*), and flower samples (*Tagetes erecta* and *Dahlia* spp.). In the case of leaf samples, a cluster consisting of four species (viz. *Mangifera indica, Melia azadirachta,*

Table 5. Polyphenol characteristics of seed coats, g/100 g.

Species	Family	Concentration		Fla/TPh
		TPh	Fla	
Buchanania lanzan Spreng.	Anacardiaceae	1.54±0.05	0.81±0.02	0.53
Pistacia vera L.	Anacardiaceae	0.35±0.01	0.11±0.01	0.31
Basella rubra L.	Basellaceae	1.14±0.03	1.05±0.03	0.92
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	2.52±0.06	0.53±0.01	0.21
Terminalia chebula Retz.	Combretaceae	5.11±0.12	4.23±0.09	0.83
Terminalia catappa L.	Combretaceae	2.24±0.05	1.07±0.03	0.48
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Combretaceae	4.86±0.13	3.13±0.11	0.64
Cucurbita maxima Duchesne	Cucurbitaceae	0.31±0.01	0.19±0.01	0.61
Lagenaria siceraria (Molina) Standl.	Cucurbitaceae	1.44±0.03	0.89±0.02	0.62
Citrullus lanatus var. *lanatus*	Cucurbitaceae	1.85±0.04	1.31±0.03	0.71
Luffa aegyptiaca Mill.	Cucurbitaceae	0.31±0.01	0.25±0.01	0.81
Cucumis melo var. *cantalupo* Ser.	Cucurbitaceae	0.29±0.01	0.21±0.01	0.72
Luffa acutangula Roxb.	Cucurbitaceae	0.83±0.02	0.72±0.02	0.87
Benincasa hispida (Thunb.) Cogn.	Cucurbitaceae	0.29±0.01	0.26±0.01	0.90
Momordica charantia L.	Cucurbitaceae	0.70±0.02	0.35±0.01	0.50
Jatropha curcas L.	Euphorbiaceae	1.47±0.03	0.40±0.01	0.27
Acacia nilotica Schumach. & Thonn.	Fabaceae	1.38±0.03	0.13±0.01	0.09
Pterocarpus marsupium Roxb.	Fabaceae	2.58±0.05	0.38±0.01	0.15
Entada gigas (L.) Fawc. & Rendle	Fabaceae	2.69±0.05	0.39±0.01	0.14
Juglans regia L.	Juglandaceae	0.96±0.03	0.19±0.01	0.20
Gmelina arborea Roxb. ex Sm.	Lamiaceae	0.46±0.01	0.13±0.01	0.28
Litsea glutinosa (Lour.) C.B.Rob.	Lauraceae	2.92±0.05	2.69±0.05	0.92
Thespesia populnea Sol. ex Corrêa	Malvaceae	1.68±0.04	0.80±0.02	0.48
Gossypium arboreum L.	Malvaceae	0.40±0.01	0.35±0.01	0.88
Melia azadirachta L.	Meliaceaa	0.18±0.01	0.12±0.01	0.67
Nelumbo nucifera Gaertn.	Nelumbonaceae	2.84±0.07	0.49±0.02	0.17
Phyllanthus emblica L.	Phyllanthaceae	2.70±0.06	0.35±0.01	0.13
Hordeum vulgare L.	Poaceae	0.41±0.01	0.10±0.01	0.24
Paspalum scrobiculatum L.	Poaceae	1.13±0.03	0.50±0.02	0.44
Ziziphus mauritiana Lam.	Rhamnaceae	0.37±0.01	0.12±0.01	0.32
Aegle marmelos Corrêa	Rutaceae	2.01±0.04	0.46±0.02	0.23
Murraya koenigii Spreng.	Rutaceae	3.23±0.07	2.53±0.05	0.78

Table 5 continued..

Species	Family	Concentration		Fla/TPh
		TPh	Fla	
Santalum album L.	Santalaceae	1.09±0.03	0.62±0.02	0.57
Schleichera oleosa (Lour.) Oken	Sapindaceae	0.85±0.02	0.54±0.02	0.64
Manilkara zapota (L.) P.Royen	Sapotaceae	1.16±0.02	0.22±0.01	0.19
Mimusops elengi L.	Sapotaceae	2.39±0.06	0.61±0.02	0.26
Madhuca indica J.F.Gmel.	Sapotaceae	0.81±0.02	0.21±0.01	0.26

Cordia dichotoma and *Dalbergia sissoo*) was highlighted. For seed samples (cluster graph not shown), those with contents >3 g 100 g^{-1} were grouped in a separate cluster, viz. *Argemone mexicana, Sesamum radiatum, Papaver somniferum, Nigella sativa, Arachis hypogaea, Passiflora foetida, Bridelia retusa, Melia azedarach* and *Shorea robusta*. If families were considered, instead of separate species, the seeds of species belonging to Bixaceae, Celastraceae, Dipterocarpaceae, Ebenaceae, Lecythidaceae, Meliaceae, Nelumbonaceae, Passifloraceae, Pedaliaceae, Papeveraceae and Ranunculaceae families were categorized into richer group-B.

Concerning the results of the correlation analysis, the r coefficients showed a high degree of correlation between the TPh and Fla contents in the case of bark (0.83), seed coat (0.80), flower (0.97), and seed (0.76) samples; a moderate degree of correlation for leaf samples (0.52); and a low degree of correlation for seed pod samples (0.11).

3.1. Tree bark

Tree barks are rich in polyphenols and other bioactive compounds, protect plants from environment and microbes, and their quantities and qualities vary between tree species and depend on the age and location of the tree, comprising from 16 to 24% of the total stem volume of a tree [17, 18]. Tree bark is generally considered a by-product and often used as combustible material for heating. Nonetheless, it can be valorized for obtaining condensed tannins, probably applied as wood adhesives, polyurethane foams, and formaldehyde scavengers [19]. Moreover, tree barks are promising sources of polyphenols, phenolic acids, flavonoids, and catechins, as well as sugars [20]. For instance, the bark from *Terminalia arjuna* is rich in catechin (8.85±0.25), gallocatechin (4.10±0.06), epigallocatechin (0.34±0.01) and ellagic acid derivatives (98.1±0.98 mg g^{-1} as ellagic acid equivalents) [21].

In the present work, 73 bark samples belonging to 28 families (viz. Anacardiaceae, Annonaceae, Apocynaceae, Arecaceae, Bignoniaceae, Bombaceae, Borangiaceae, Combretaceae, Dipterocarpaceae, Fabaceae, Ebenaceae, Euphorbiaceae, Lamiaceae, Lythraceae, Lecythidaceae, Meliaceae, Moraceae, Moringaceae Myrtaceae, Oleaceae, Phyllanthaceae, Rhamnaceae, Rubiaceae, Rutaceae, Sapindaceae, Sapotaceae, Simaroubaceae and Verbenaceae) were analyzed, finding TPh contents in the 0.15-5.30 g 100 g^{-1} range and flavonoid contents in the 0.11-4.20 g 100 g^{-1} range, with [Fla]/[TPh] ratios ranging from 0.07 to 1.00. Maximum TPh values (> 5 g 100 g^{-1}) were recorded for the bark samples from *Magnifera indica* and *Moringa oleifera* (see Table 1).

3.2. Leaf

Leaves have widespread applications as food and herbal medicine sources [22]. Leaves from medicinal plants are frequently used as raw materials for the extraction of active ingredients that are used for laxatives, blood thinners, antibiotics, anti-malaria medications, treatment of coronary heart disease, etc. [23]. For instance,

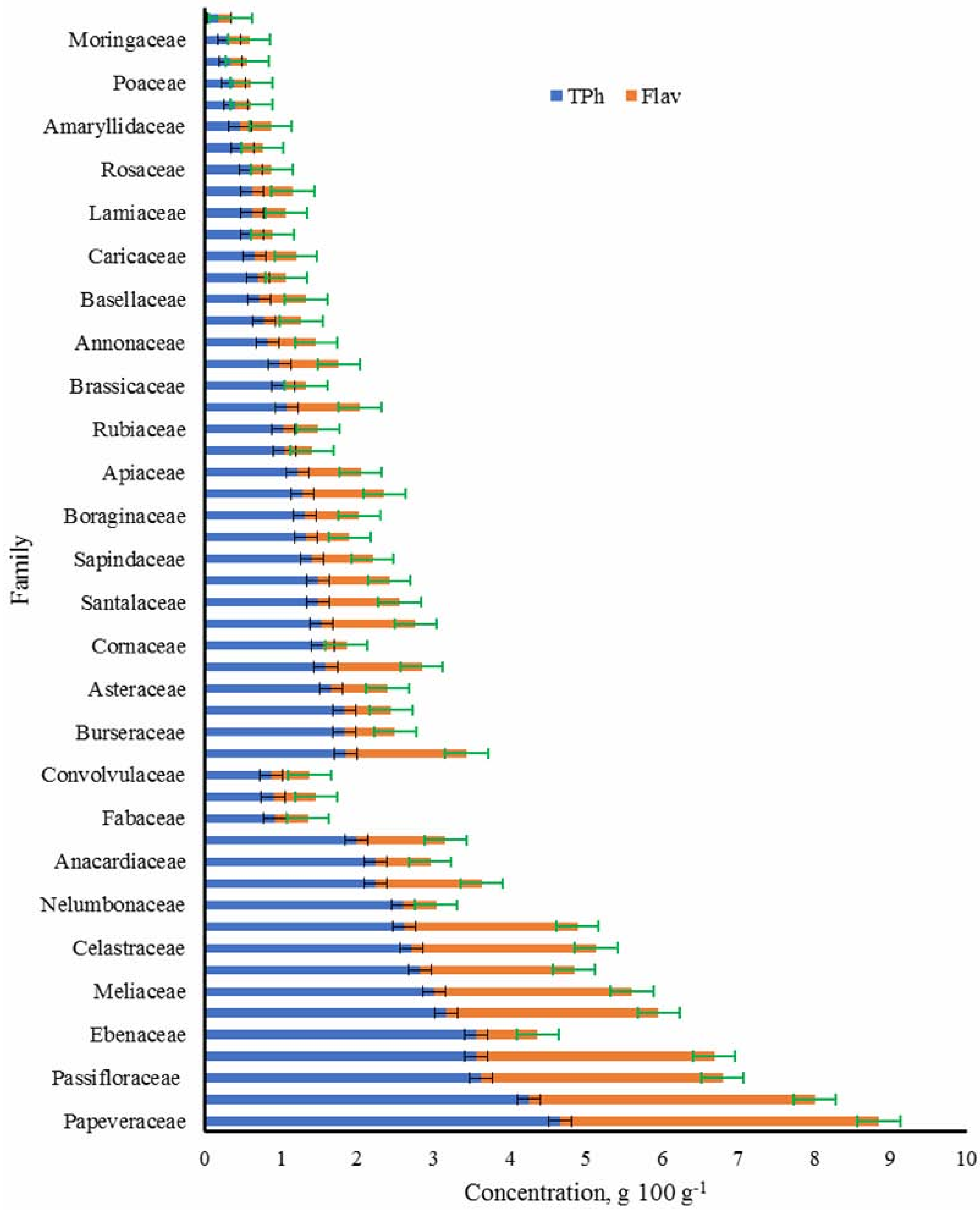

Figure 1. Variation in polyphenol concentration in seed with respect to family.

Agarista salicifolia leaf extract has been reported to contain flavan-3-ols, phenolic acids, flavonols, and dihydrochalcones [24]. Twenty-five flavonoid and phenolic acids have been detected in the leaves of elephant-head amaranth (*Amaranthus tricolor*, syn. *A. gangeticus*) [25]. The TPh content of leaves of eight species belonging to Lamiaceae family (viz. *Gmelina arborea*, *Hyptis suaveolens*, Leonotis nepetifolia, Ocimum americanum, Ocimum sanctum, Ocimum tenuiflorum, Origanum vulgare and *Tectona grandis*) has been found to vary from 1.54 to 2.99 g 100 g^{-1} [4]. The TPh and Fla contents in common weeds *Rorippa palustris*, *Euphorbia rothiana* and *Schoenoplectiella articulata* have been reported to range from 4.79 to 7.38 g 100 g^{-1} and from 0.12 to 0.94 g 100 g^{-1}, respectively [12].

The polyphenol contents of 62 leaf samples from plants belonging to 28 families (Anacardiaceae, Annonaceae, Apiaceae, Araceae, Asteraceae, Borangiaceae, Combretaceae, Cucurbitaceae, Fabaceae, Euphorbiaceae, Lamiaceae, Lauraceae, Linaceae, Lythraceae, Malvaceae, Meliaceae, Moraceae, Moringaceae, Myrtaceae, Oleaceae, Phyllanthaceae, Rhamnaceae, Rutaceae Sapindaceae, Sapotaceae, Simaroubaceae, Solanaceae, and Verbenaceae) are summarized in Table 2. The TPh and Fla concentrations varied from 1.28 to 4.13 g 100 g^{-1} and from 1.04 to 3.76 g 100 g^{-1}, in terms of gallic acid and quercetin equivalents, respectively. The highest TPh and Fla contents corresponded to the leaves from *Mangifera indica*, followed by *Melia azadirachta*, *Cordia dichotoma*, *Dalbergia sissoo* and *Moringa oleifera*.

Agronomical variables i.e., color, mass, moisture content, plant type and family influence the TPh production in leaves. The light green colored leaves (mean value, 2.81 mg 100 g^{-1}) synthesized slightly higher TPh contents than the deep colored leaves (mean value, 2.45 mg 100 g^{-1}). For comparison purposes, total phenolic contents in the 0.012-5.9 g 100 g^{-1} range have been reported for *Acacia nilotica*, *Acacia catechu*, *Albizia lebbeck*, New Zealand-grown tomatoes, Mediterranean plants and Chinese medicinal plants [26-28].

3.3. Flower

Flowers are rich in polyphenols and bioactive components, and play a major role in traditional cuisine and alternative medicine [29, 30]. In the 40 flowers of three families (Fabaceae, Lythraceae and Sapindiaceae) that were analyzed in this work, TPh and Fla contents were in the range 1.8-18.7 and 1.3-18.2 g 100 g^{-1}, respectively (Table 3). The color and family of flowers greatly affected the TPh contents. Regarding other TPh concentrations reported in the literature, comparable values have been found in German chamomile (*Matricaria chamomilla*) flowers (8.3 g 100 g^{-1}) [31].

3.4. Seed pod

Seeds are major sources of food and energy, covered with seed coat, seed pod and pericarp. A higher TPh content in seed pod/pericarp and seed coat than the seed was observed. The seeds of some families (e.g., Fabaceae, Lythraceae and Sapindiaceae) are enclosed with seed pods, i.e., elongated seed vessels also known as husk, hull, shuck, pericarp, capsule, or legume. They are generally colored, containing various polyphenols that protect seeds from sunlight, water loss and microbes [32]. For instance, catechin, epicatechin, hyperoside, and isoquercitrin have been identified in the pepicarp of *Lotus* spp. seeds [33]. Likewise, the study of the pericarp of *Dimocarpus longan* revealed the presence of gallic acid, ellagic acid and 15 other phenolic profiles [34]. In this study, the TPh and Fla contents and [Fla]/[TPh] ratio were determined in 11 seed pods (Table 4), with values in the following ranges: 0.94-2.88 g 100 g^{-1}, 0.21-1.74 g 100 g^{-1} and 0.13-0.32 g 100 g^{-1}, respectively.

3.5. Seed coat

The seed coat protects the internal parts of the seed from sunlight, fungi, bacteria, insects, etc. and prevents desiccation. It is composed of cellulose, fiber, polyphenols, starch, wax, etc. Its outer layer, called testa, is generally hard and thick, while its inner layer, known as the tegmen, is softer. It plays a vital role in the life cycle of plants by controlling the development of the embryo and determining seed dormancy and germination [35]. Mung bean (*Vigna radiata*), and soy bean (*Glycine max*) seed coats possess TPh contents of 702-1296 and 512-6058 mg 100 g^{-1} gallic acid equivalents, respectively [36, 37], and TPh and Fla concentrations over the 0.18-3.23 and 0.12-2.69 g 100 g^{-1} ranges, respectively, as reported in 24 seed coats by Sahu *et al*. [11].

In this work, 62 seed coats from species belonging to 18 families (Anacardiaceae, Basellaceae, Combretaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Juglandaceae, Lamiaceae, Malvaceae, Meliaceaa Nelumbonaceae, Poaceae, Phyllanthaceae, Rhamnaceae, Rutaceae, Santalaceae, Sapindaceae and Sapotaceae) were analyzed. TPh and Fla contents varied from 0.18 to 5.11 g/100 g and from 0.10 to 4.23 g 100 g^{-1}, respectively, and the [Fla]/[TPh] ratio ranged from 0.09 to 0.92 g 100 g^{-1} (Table 5).

3.6. Seed

Seeds are important not only as sources of food (due to their oil, protein and starch contents), but also as a source of valuable bioactive compounds [38]. Prominent phenolics such as 1-*O*-caffeoyl-6-*O*-rhamnopyranosyl-glycopyranoside, epicatechin-gallate, orientin/isorientin, vitexin/isovitexin, hyperin and rutin have been identified in different seed fractions of buckwheat (*Fagopyrum esculentum*) [39]. Common beans (*Phaseolus vulgaris*), contain up to 4.9 g/100 g of polyphenols [40]. Several phenolic substances, including monophenol, phenolic acids, flavonoids and other polyphenols, have been identified in barley (*Hordeum vulgare*) grains [41].

In this work, TPh and Fla contents of 227 seeds belonging to 54 families (viz. Aceraceae, Amaranthaceae, Amaryllidaceae, Anacardiaceae, Annonaceae, Apiaceae, Asparagaceae, Asteraceae, Basellaceae, Bixaceae, Boraginaceae, Brassicaceae, Burseraceae, Caricaceae, Celastraceae, Cornaceae, Convolvulaceae, Cucurbitaceae, Dipterocarpaceae Ebenaceae, Euphorbiaceae, Fabaceae, Juglandaceae, Lamiaceae, Lauraceae, Lecythidaceae, Linaceae, Loganiaceae, Lythraceae, Malvaceae, Meliaceae, Moraceae, Moringaceae, Myrtaceae, Nelumbonaceae, Papeveraceae, Passifloraceae, Pedaliaceae, Piperacee, Poaceae, Polygonaceae, Phyllanthaceae, Putranjivaceae, Rhamnaceae, Ranunculaceae, Rosaceae, Rubiaceae, Rutaceae, Santalaceae, Sapindaceae, Sapotaceae, Schisandraceae, Solanaceae and Verbenaceae) were quantified. TPh and Fla contents varied from 0.01 to 5.00 g 100 g^{-1} and from 0.01 to 4.47 g 100 g^{-1}, respectively, and the [Fla]/[TPh] ratio ranged from 0.05 to 1.00 (Table S1).

On comparing, the TPh contents of *Terminalia* spp. seeds (*T. arjuna*, *T. bellerica*, *T. catappa* and *T. chebula*), Sapotaceae seeds (*Madhuca indica*, *Manilkara zapota* and *Mimusops elengi*), *Abrus precatorius* and Caesalpinioideae seeds (*Delonix regia*, *Entada gigas*, *Leucaena leucocephala*, *Mimosa pudica*, *Parkia javanica* and *Senna siamea*) were found to be 0.2-5.1, 0.2-2.3, 1.42 and 0.1-1.9 g 100 g^{-1}, respectively [5-8]. The concentrations of total phenolic and flavonoid compounds in 47 seeds from species belonging to Arecaceae, Amaranthaceae, Anacardiaceae, Asteraceae, Fabaceae, Lamiaceae, Malvaceae, Rutaceae, Sapindaceae and Sapotaceae have been reported to range from 0.19 to 3.44 g 100 g^{-1} and from 0.12 to 2.52 mg 100 g^{-1}, evaluated as gallic acid (GAE) and quercetin (QE) equivalents, respectively [42]. In a larger screening carried out on seeds from 155 species, TPh contents of up to 5 g 100 g^{-1} have also been reported [9].

The highest TPh contents (> 4 g 100 g^{-1}) corresponded to *Argemone mexicana*, *Sesamum radiatum*, *Papaver somniferum*, *Nigella sativa*, *Solena amplexicaulis* and *Bridelia retusa* seeds. If Fla contents are considered, the highest concentrations were found in four of aforementioned species (*Argemone mexicana*, *Sesamum radiatum*, *Papaver somniferum* and *Nigella sativa*), followed by *Arachis hypogaea* and *Passiflora foetida*.

4. CONCLUSIONS

The average TPh content in the various plant parts under study was found to follow the sequence: flower (5.96 g 100 g^{-1}) > leaf (2.73 g 100 g^{-1}) > seed pod (2.19 g 100 g^{-1}) > seed coat (1.55 g 100 g^{-1}) > seed (1.19 g 100 g^{-1}) > bark samples (1.10 g 100 g^{-1}). The flowers from *Tagetes erecta* and *Dahlia* spp.; the leaves from *Mangifera indica*, *Melia azadirachta*, *Cordia dichotoma* and *Dalbergia sissoo*; the seed pods from *Acacia nilotica*; the seed coats from *Terminalia chebula* and *T. arjuna*; the seeds from *Argemone mexicana*, *Sesamum radiatum*, *Papaver somniferum*, *Nigella sativa*, *Arachis hypogaea*, *Passiflora foetida, Bridelia retusa*, *Melia azedarach* and *Shorea robusta*; and the bark from *Mangifera indica* and *Moringa oleifera* can be regarded as the richest sources of polyphenols in their respective classes. Thus, they may deserve further attention as promising functional foods, natural preservatives, or supplementary additives to feed animals.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Khageshwar Singh Patel: Conceptualization, writing – original draft & review.

Pravin Kumar Sahu: Sampling & processing.

Suryakant Chakradhari: Analysis & data curation.

Piyush Kant Pandey: Supervision & resource.

Pablo Martín-Ramos: Writing – review & editing.

José A. Rufián-Henares: Validation & editing.

Simge Varol: Review & graphics.

Yanbei Zhu: Support & editing.

DATA AVAILABILITY

Data will be made available on request.

CONFLICT OF INTEREST STATEMENT

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

SUPPLEMENTARY INFORMATION

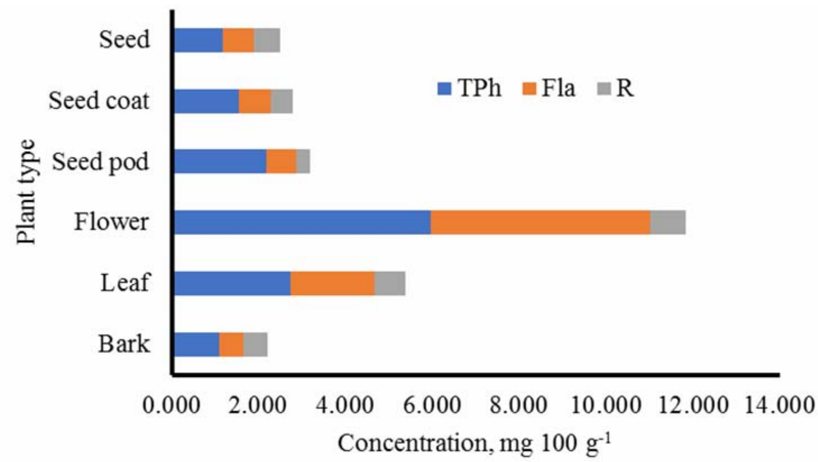

Figure S1(A). TPh, Fla and R [Fla]/[TPh] variation with respect to plant type.

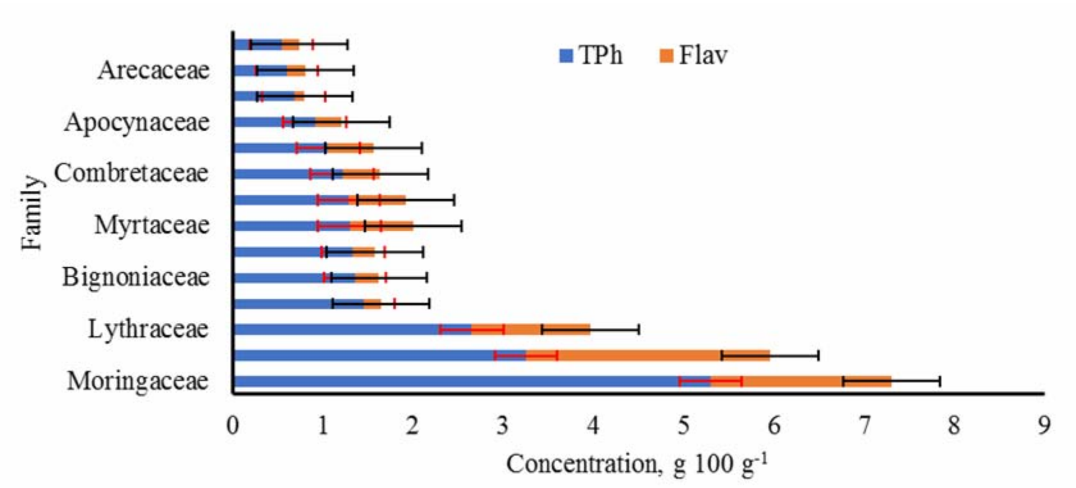

Figure S1(B). Variation in polyphenol concentration in bark with respect to family.

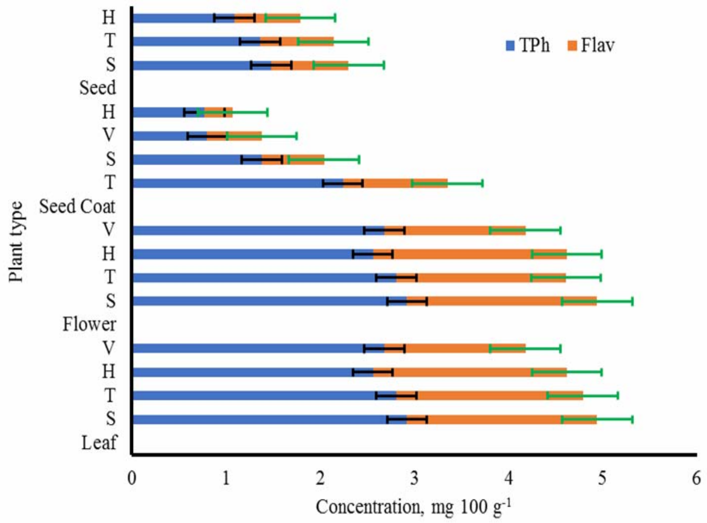

Figure S1(C). Polyphenol variation with respect to plant type.

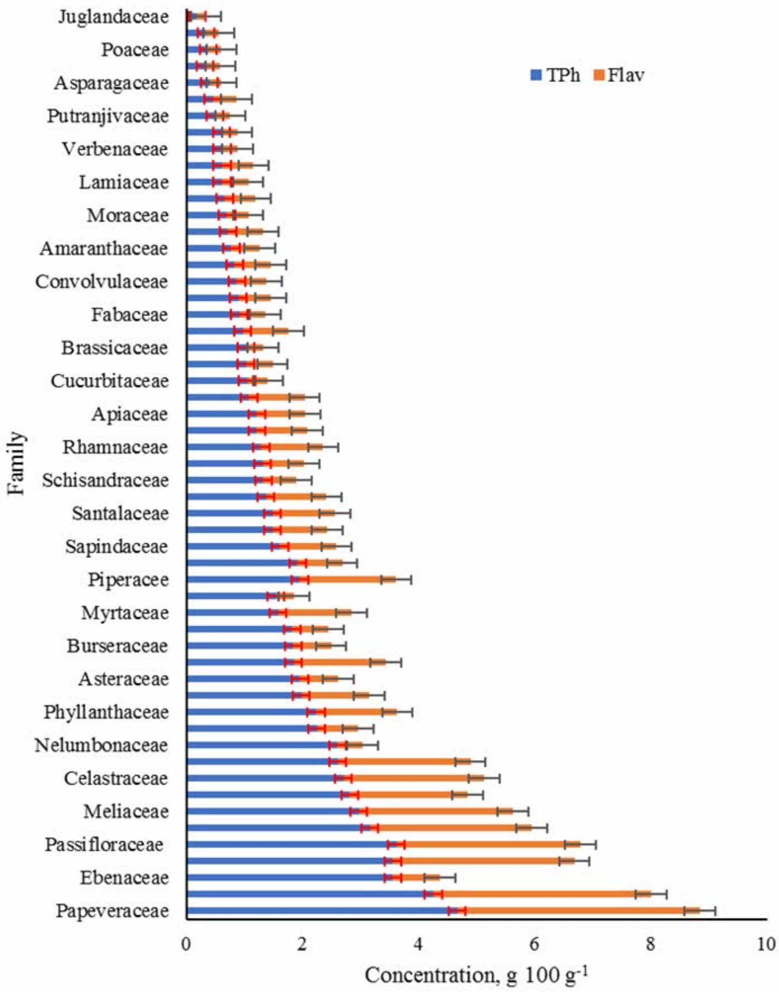

Figure S1(D). Variation in polyphenol concentration in leaves with respect to family.

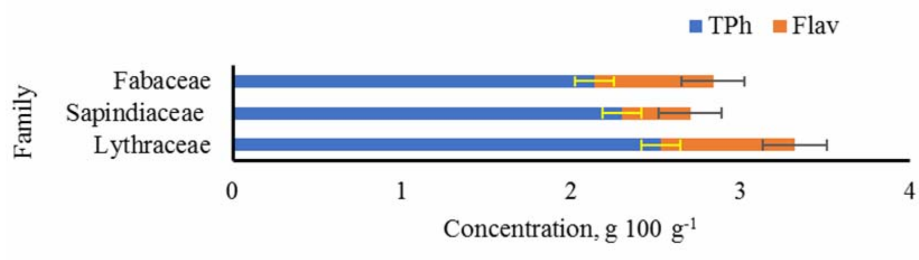

Figure S1(E). Variation in polyphenol concentration in flowers with respect to family.

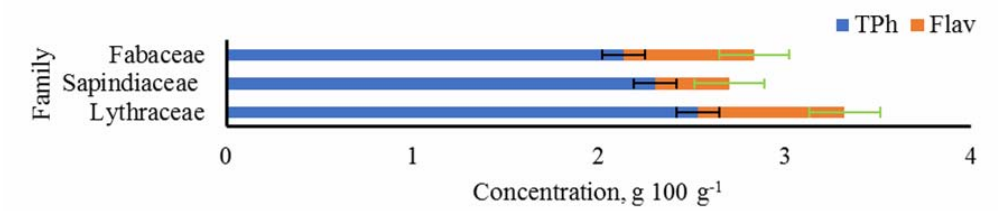

Figure S1(F). Variation in polyphenol concentration in seed pods with respect to family.

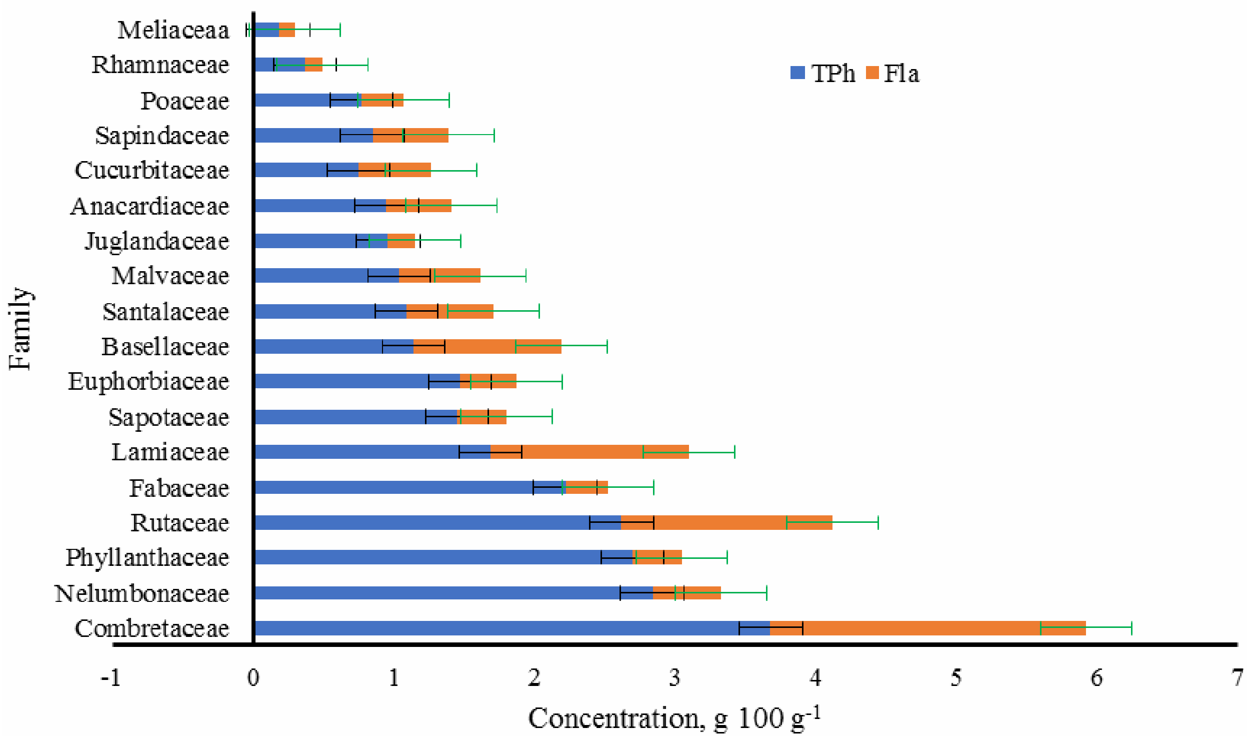

Figure S1(G). Variation in polyphenol concentration in seed coats with respect to family.

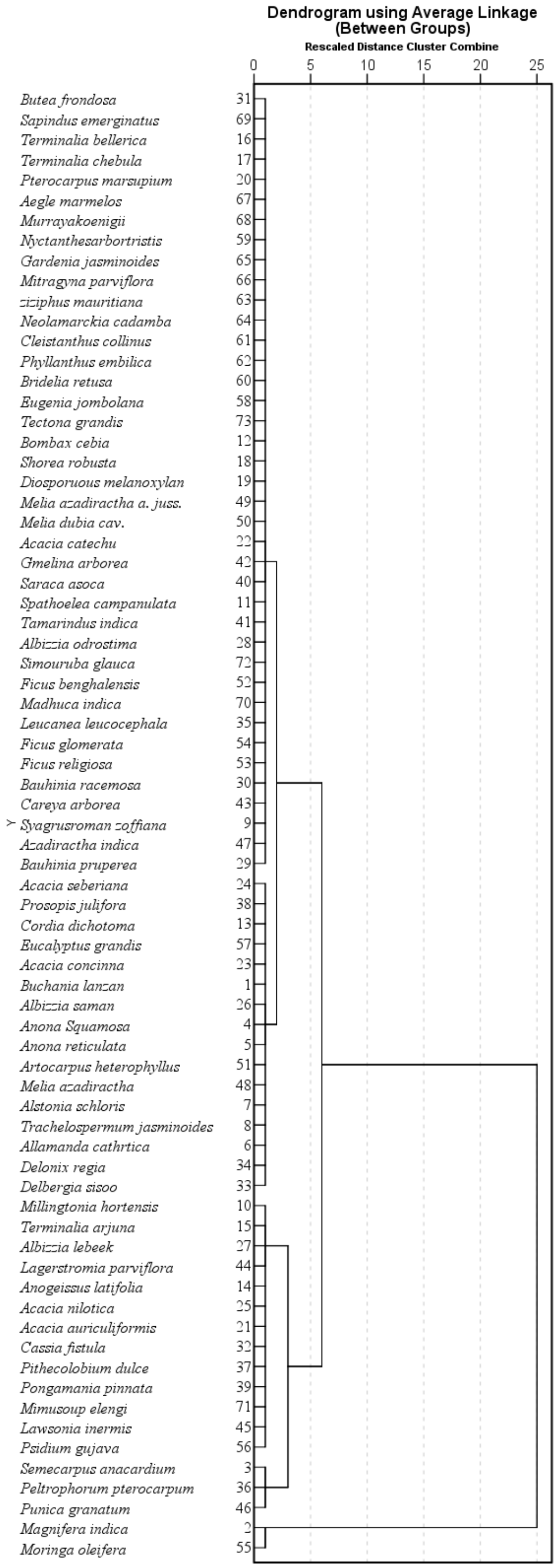

Figure S2(A). Cluster analysis of TPh content data in bark samples.

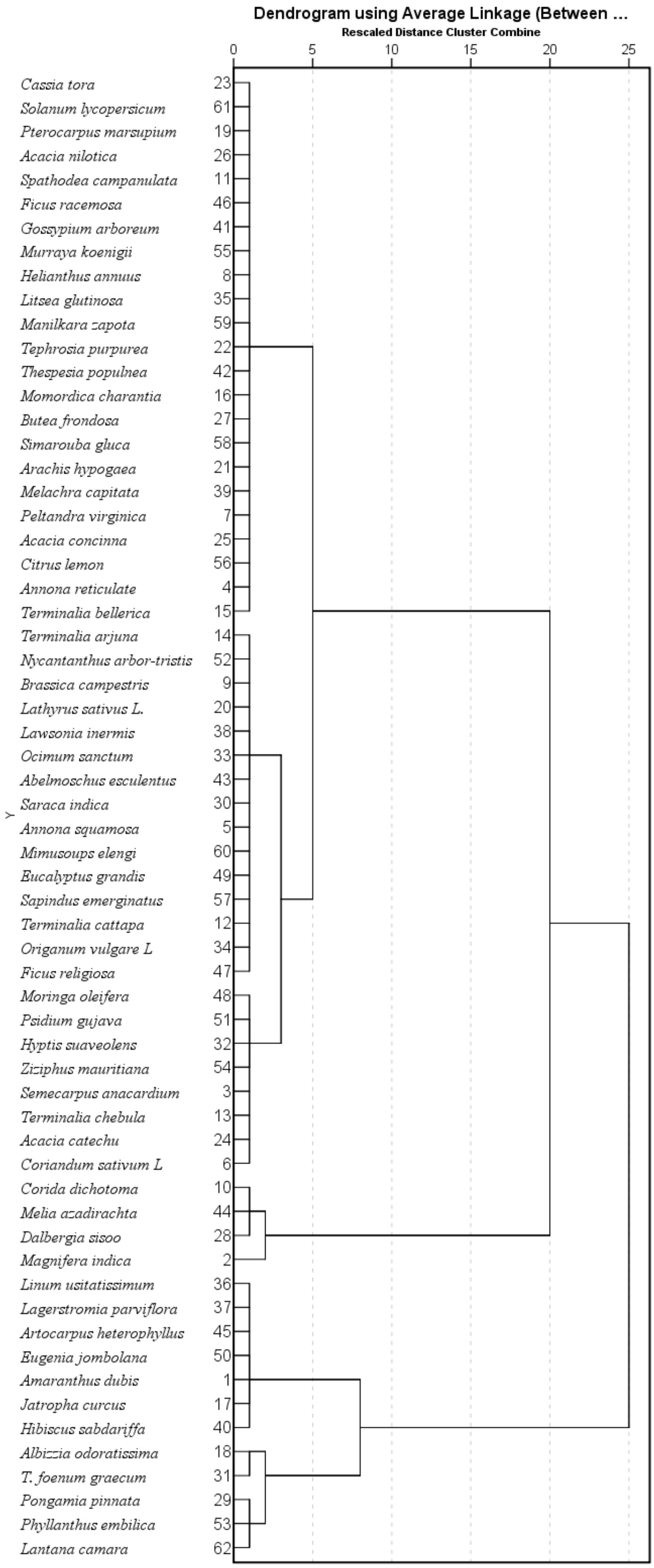

Figure S2(B). Cluster analysis of TPh content data in leaf samples.

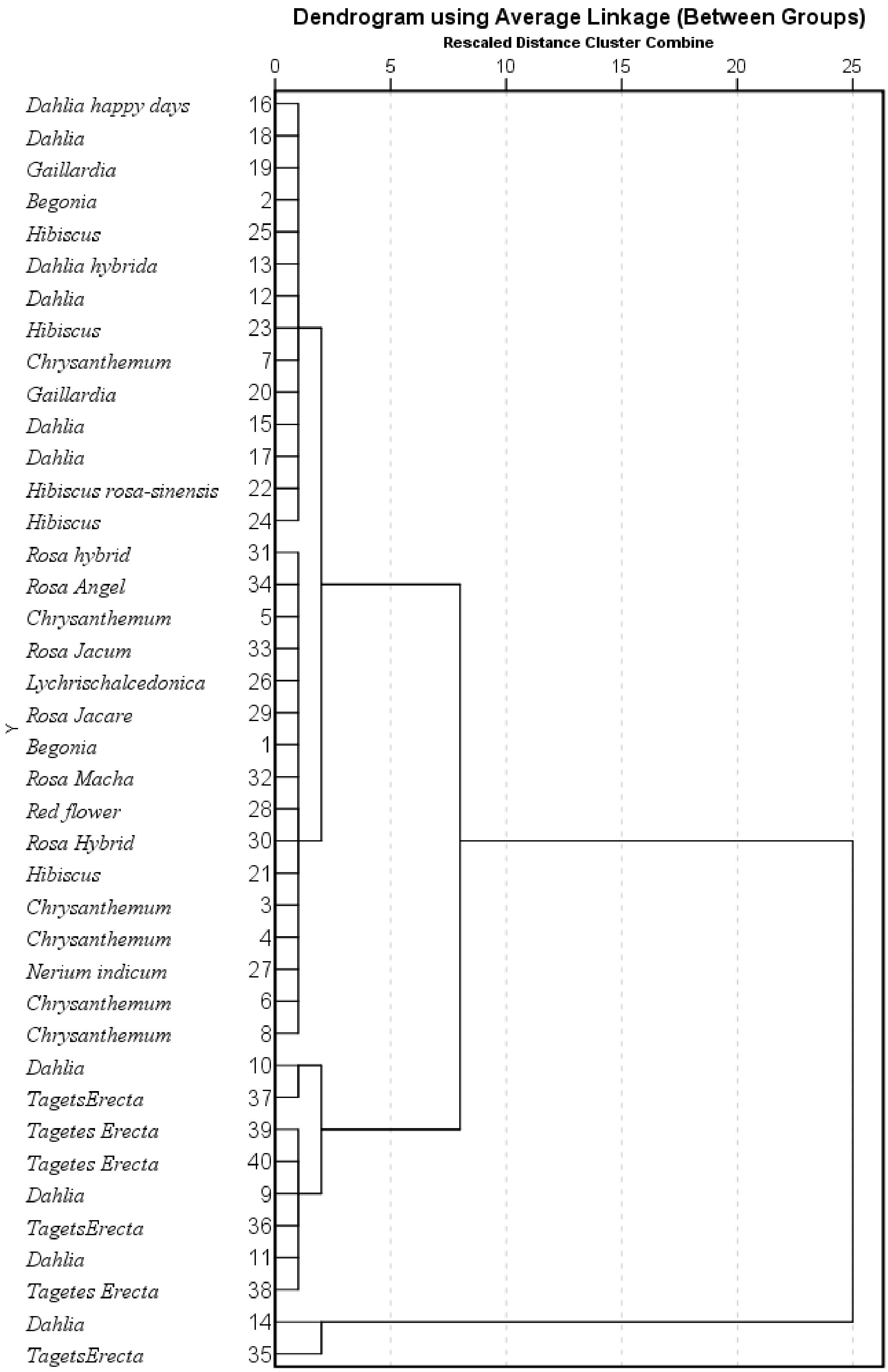

Figure S2(C). Cluster analysis of TPh content data in flower samples.

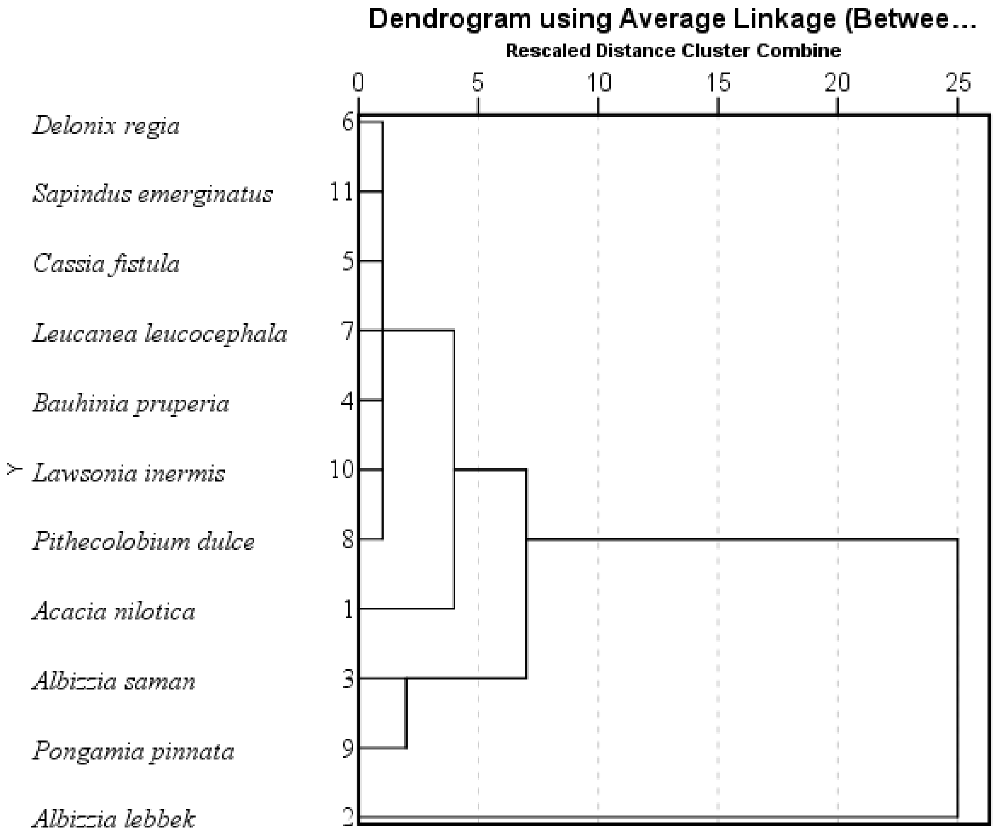

Figure S2(D). Cluster analysis of TPh content data in seed coat samples.

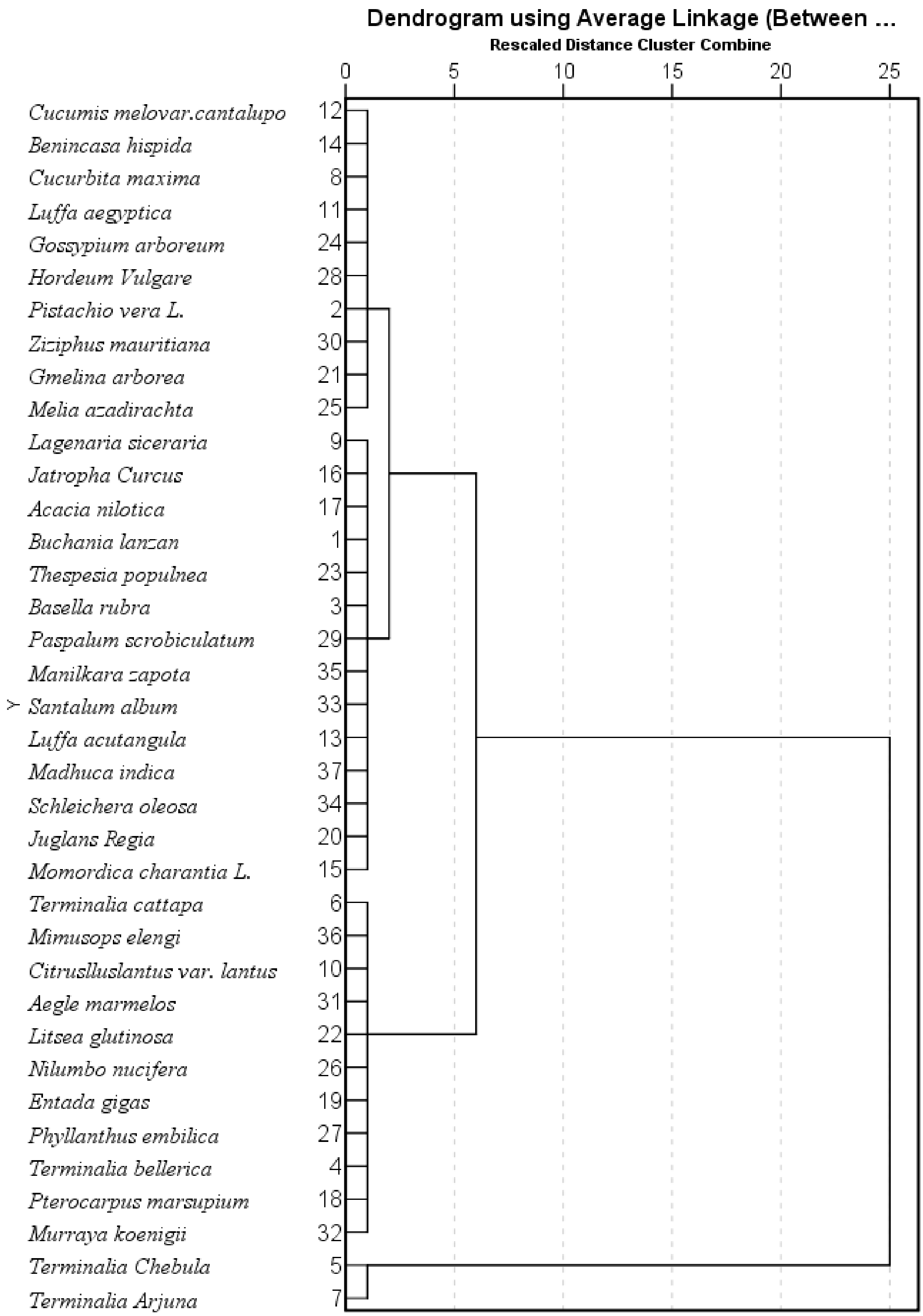

Figure S2(E). Cluster analysis of TPh content data in seed pod samples.

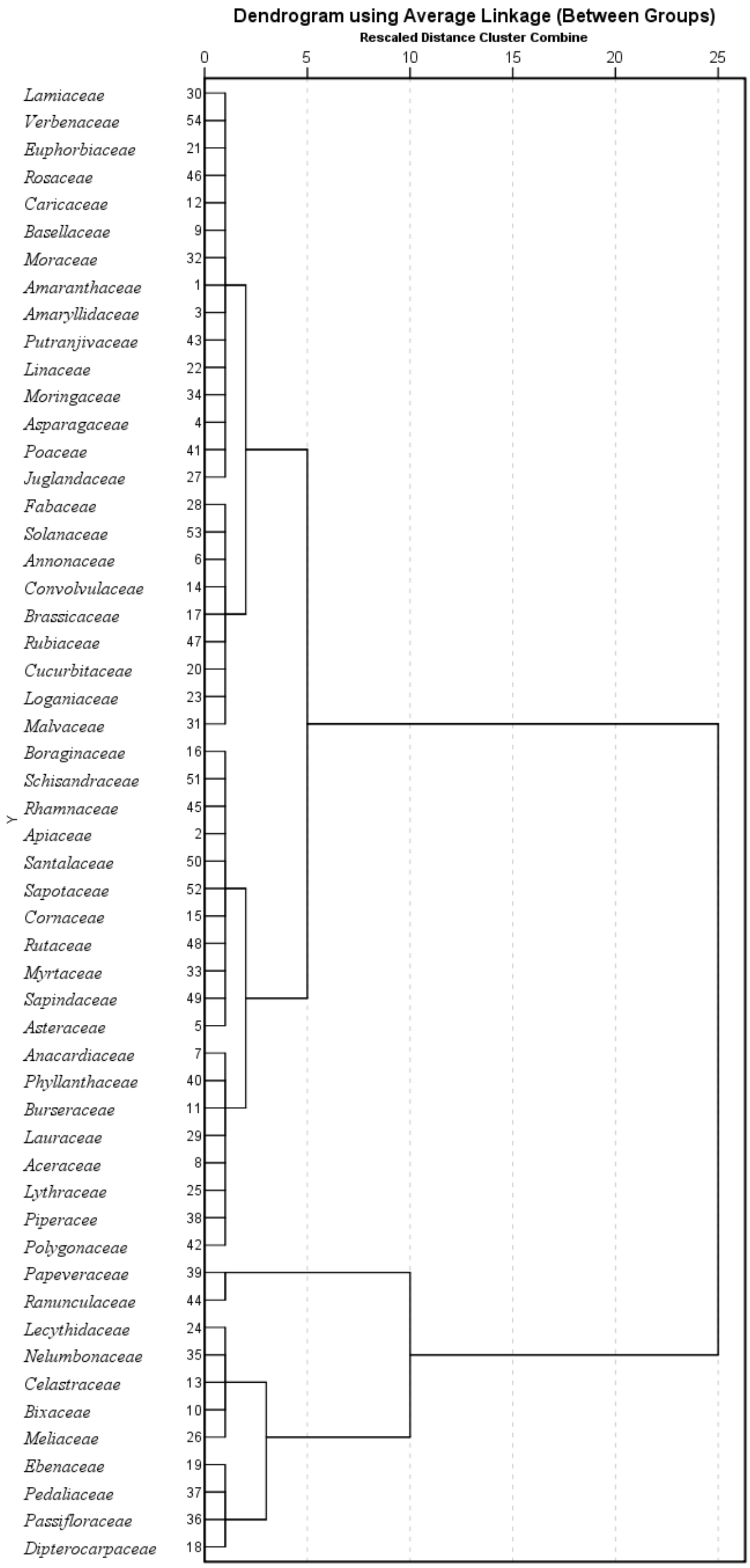

Figure S2(F). Cluster analysis of TPh content data in seed samples.

Table S1. Polyphenol characteristics in seeds, g/100 g.

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Amaranthus dubius Mart.	Amaranthaceae	H	1.02±0.03	0.93±0.02	0.91
Amaranthus gangeticus L.	Amaranthaceae	H	0.35±0.01	0.33±0.01	0.94
Amaranthus viridis L.	Amaranthaceae	H	0.32±0.01	0.31±0.01	0.97
Beta vulgaris L.	Amaranthaceae	H	1.58±0.04	0.28±0.01	0.18
Celosia argentea L.	Amaranthaceae	H	0.70±0.02	0.65±0.02	0.93
Spinacia oleracea L.	Amaranthaceae	H	0.65±0.03	0.42±0.01	0.65
Coriandrum sativum L.	Apiaceae	H	0.48±0.01	0.41±0.01	0.85
Cuminum cyminum L.	Apiaceae	H	0.90±0.02	0.82±0.02	0.91
Daucus carota subsp. *sativus* (Hoffm.) Schübl. & Martens	Apiaceae	H	1.69±0.03	1.49±0.03	0.88
Foeniculum vulgare Mill.	Apiaceae	H	1.06±0.02	0.88±0.02	0.83
Trachyspermum ammi Sprague	Apiaceae	H	1.90±0.05	0.53±0.02	0.28
Allium cepa L.	Amaryllidaceae	H	0.45±0.02	0.41±0.02	0.91
Asparagus racemosus Willd.	Asparagaceae	H	0.40±0.01	0.20±0.01	0.50
Helianthus annuus L.	Asteraceae	H	0.59±0.02	0.49±0.02	0.83
Stevia rebaudiana Bertoni	Asteraceae	H	3.44±0.08	0.26±0.01	0.08
Carthamus oxyacanthus M.Bieb.	Asteraceae	H	1.82±0.05	1.24±0.03	0.68
Anacardium occidentale L.	Anacardiaceae	T	0.86±0.02	0.12±0.01	0.14
Buchanania lanzan Spreng.	Anacardiaceae	T	2.59±0.05	0.41±0.01	0.16
Mangifera indica L.	Anacardiaceae	T	2.58±0.05	0.79±0.02	0.31
Pistacia vera L.	Anacardiaceae	T	2.71±0.06	0.19±0.01	0.07
Semecarpus anacardium L.f.	Anacardiaceae	T	2.48±0.05	2.05±0.04	0.83
Annona squamosa L.	Annonaceae	T	0.82±0.02	0.63±0.02	0.77
Areca catechu L. (Indian nut)	Aceraceae	T	1.55±0.04	1.24±0.03	0.80
Areca catechu L. (Chikni Supari)	Aceraceae	T	2.43±0.05	0.48±0.01	0.20
Phoenix dactylifera L.	Aceraceae	T	0.77±0.02	0.35±0.01	0.45
Phoenix sylvestris Roxb.	Aceraceae	T	0.93±0.02	0.77±0.02	0.83
Carthamus oxyacanthus M.Bieb.	Asteraceae	H	0.59±0.01	0.49±0.01	0.83
Helianthus annuus L.	Aceraceae	H	3.44±0.07	0.26±0.01	0.08
Stevia rebaudiana Bert.	Asteraceae	H	1.82±0.04	1.24±0.03	0.68
Basella rubra L.	Basellaceae	V	0.71±0.02	0.61±0.02	0.86
Bixa orellana L.	Bixaceae	S	2.81±0.05	2.03±0.04	0.72
Trichodesma indicum R.Br.	Boraginaceae	H	1.44±0.03	0.61±0.01	0.42

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Heliotropium indicum L.	Boraginaceae	H	1.17±0.03	0.80±0.02	0.68
Brassica campestris L.	Brassicaceae	H	1.47±0.03	0.23±0.01	0.16
Brassica hirta Moench	Brassicaceae	H	1.90±0.04	0.19±0.01	0.10
Brassica nigra (L.) W.D.J.Koch (Rai)	Brassicaceae	H	1.29±0.03	0.25±0.01	0.19
Brassica oleracea f. *alba* DC.	Brassicaceae	H	1.79±0.05	0.24±0.01	0.13
Brassica oleracea var. *botrytis* L.	Brassicaceae	H	0.97±0.02	0.29±0.01	0.30
Brassica rapa L.	Brassicaceae	H	0.47±0.01	0.38±0.01	0.81
Lepidium sativum L.	Brassicaceae	H	0.38±0.01	0.32±0.01	0.84
Raphanus sativus L.	Brassicaceae	H	0.27±0.01	0.24±0.01	0.89
Sisymbrium irio L.	Brassicaceae	H	0.68±0.02	0.59±0.02	0.87
Commiphora wightii (Arn.) Bhandari	Burseraceae	S	1.83±0.03	0.66±0.02	0.36
Carica papaya L.	Caricaceae	S	0.65±0.02	0.54±0.01	0.83
Celastrus paniculatus Willd.	Celastraceae	V	2.70±0.06	2.43±0.06	0.90
Ipomoea aquatica Forssk.	Convolvulaceae	H	0.86±0.02	0.51±0.01	0.59
Alangium salviifolium (L.f.) Wangerin	Cornaceae	S	1.54±0.04	0.31±0.01	0.20
Benincasa hispida (Thunb.) Cogn.	Cucurbitaceae	V	0.45±0.01	0.23±0.01	0.51
Citrullus lanatus var. *lanatus*	Cucurbitaceae	V	0.91±0.02	0.73±0.02	0.80
Cucumis melo var. *flexuosus* Naud.	Cucurbitaceae	V	0.36±0.01	0.24±0.01	0.67
Cucumis melo var. *cantalupo* Ser.	Cucurbitaceae	V	0.44±0.01	0.34±0.01	0.77
Cucumis sativus L.	Cucurbitaceae	V	0.44±0.01	0.36±0.01	0.82
Cucurbita maxima Duchesne	Cucurbitaceae	V	0.54±0.02	0.11±0.01	0.20
Diplocyclos palmatus (L.) C.Jeffrey	Cucurbitaceae	V	0.50±0.02	0.30±0.01	0.60
Lagenaria siceraria (Molina) Standl.	Cucurbitaceae	V	1.32±0.03	1.14±0.03	0.86
Luffa acutangula Roxb.	Cucurbitaceae	V	0.24±0.01	0.14±0.01	0.58
Luffa aegyptiaca Mill.	Cucurbitaceae	V	0.31±0.01	0.25±0.01	0.81
Momordica charantia L. (Big karela)	Cucurbitaceae	V	0.20±0.01	0.12±0.01	0.60

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Momordica charantia L. (Small karela)	Cucurbitaceae	V	3.39±0.06	0.17±0.01	0.05
Praecitrullus fistulosus (Stocks) Pangalo	Cucurbitaceae	V	1.25±0.03	0.47±0.01	0.38
Solena amplexicaulis (Lam.) Gandhi	Cucurbitaceae	V	4.21±0.09	0.39±0.01	0.09
Shorea robusta C.F.Gaertn.	Dipterocarpaceae	T	3.16±0.07	2.79±0.04	0.88
Diospyros melanoxylon Roxb.	Ebenaceae	T	3.55±0.08	0.81±0.02	0.23
Jatropha curcas L.	Euphorbiaceae	S	0.50±0.01	0.43±0.01	0.86
Ricinus communis L.	Euphorbiaceae	S	0.72±0.02	0.65±0.02	0.90
Acacia auriculiformis Benth.	Fabaceae	T	0.43±0.01	0.38±0.01	0.88
Acacia catechu (L.f.) Willd.	Fabaceae	T	0.95±0.02	0.37±0.01	0.39
Acacia concinna (Willd.) DC.	Fabaceae	T	0.72±0.02	0.30±0.01	0.42
Acacia nilotica Schumach. & Thonn.	Fabaceae	T	0.26±0.01	0.26±0.01	1.00
Albizia saman (Jacq.) Merr.	Fabaceae	T	0.52±0.01	0.46±0.01	0.88
Albizia lebbeck (L.) Benth. (Siris)	Fabaceae	T	0.69±0.02	0.41±0.01	0.59
Albizia odoratissima (L.f.) Benth.	Fabaceae	T	0.47±0.01	0.43±0.01	0.91
Bauhinia purpurea L.	Fabaceae	T	1.21±0.03	0.46±0.01	0.38
Bauhinia racemosa Lam.	Fabaceae	T	2.35±0.05	0.42±0.01	0.18
Bauhinia vahlii Wight & Arn.	Fabaceae	T	0.29±0.01	0.27±0.01	0.93
Butea frondosa Roxb.	Fabaceae	T	1.82±0.04	0.41±0.01	0.23
Caesalpinia decapetala (Roth) Alston	Fabaceae	T	0.39±0.01	0.35±0.01	0.90
Caesalpinia pulcherrima (L.) Sw.	Fabaceae	S	2.81±0.06	2.10±0.05	0.75
Cassia fistula L.	Fabaceae	T	0.82±0.02	0.46±0.01	0.56
Pithecellobium dulce (Roxb.) Benth.	Fabaceae	T	0.39±0.01	0.34±0.01	0.87
Pongamia pinnata (L.) Pierre	Fabaceae	T	0.48±0.01	0.41±0.01	0.85
Saraca asoca (Roxb.) Willd.	Fabaceae	T	1.61±0.04	1.39±0.03	0.86
Sesbania grandiflora (L.) Pers.	Fabaceae	T	1.77±0.04	0.55±0.02	0.31
Hardwickia binata Roxb.	Fabaceae	T	3.49±0.08	0.58±0.02	0.17
Pterocarpus marsupium Roxb.	Fabaceae	T	2.90±0.07	0.34±0.01	0.12
Tamarindus indica L.	Fabaceae	T	0.30±0.01	0.27±0.01	0.90
Sesbania cannabina (Retz.) Pers.	Fabaceae	S	2.23±0.05	0.50±0.01	0.22

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Enterolobium cyclocarpum (Jacq.) Griseb.	Fabaceae	T	0.42±0.01	0.33±0.01	0.79
Gliricidia maculata (Kunth) Steud.	Fabaceae	T	1.02±0.02	0.36±0.01	0.35
Delonix regia (Bojer) Raf.	Fabaceae	T	0.38±0.01	0.29±0.01	0.76
Entada gigas (L.) Fawc. & Rendle (Hanuman Jadi)	Fabaceae	V	1.88±0.04	0.27±0.01	0.14
Leucaena leucocephala (Lam.) de Wit	Fabaceae	S	1.24±0.03	0.32±0.01	0.26
Mimosa pudica L.	Fabaceae	V	1.85±0.04	0.63±0.02	0.34
Parkia javanica Merr.	Fabaceae	T	0.99±0.02	0.91±0.02	0.92
Senna siamea (Lamarck) H.S.Irwin & Barneby	Fabaceae	T	0.42±0.01	0.31±0.01	0.74
Cicer arietinum L.	Fabaceae	H	0.01	0.01	1.00
Cicer arietinum L.	Fabaceae	H	0.02	0.01	0.50
Lathyrus angulatus L.	Fabaceae	H	0.07±0.01	0.01	0.14
Lathyrus sativus L.	Fabaceae	H	0.05	0.01	0.20
Pisum sativum L. (Green matar)	Fabaceae	H	0.05	0.01	0.20
Pisum sativum L. (Whitish matar)	Fabaceae	H	0.15±0.01	0.01	0.07
Pisum sativum subsp. *arvense* (L.) Asch. & Graebn.	Fabaceae	H	0.04	0.01	0.25
*Cajanus cajan (*L.) Millsp.	Fabaceae	H	0.57±0.02	0.03	0.05
Cyamopsis tetragonoloba Taub.	Fabaceae	H	0.30±0.01	0.02	0.07
Lens culinaris Medik.	Fabaceae	H	0.06	0.05	0.83
Macrotyloma uniflorum (Lam.) Verdc. (Black Kulthi)	Fabaceae	H	0.21±0.01	0.08	0.38
Macrotyloma uniflorum (Lam.) Verdc. (Brown Kulthi)	Fabaceae	H	0.04	0.02	0.50
Vigna mungo (L.) Hepper	Fabaceae	H	0.11±0.01	0.02	0.18
Vigna radiata (L.) R.Wilczek	Fabaceae	H	0.57±0.02	0.03	0.05
Glycine max (L.) Merr.	Fabaceae	H	0.08	0.01	0.13
Lablab purpureus (L.) Sweet (Green Semi)	Fabaceae	V	0.05	0.01	0.20
Lablab purpureus (L.) Sweet (White Semi)	Fabaceae	V	0.05	0.01	0.20
Lablab purpureus (L.) Sweet (Purple Semi)	Fabaceae	V	0.06	0.01	0.17

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Phaseolus vulgaris L.	Fabaceae	V	0.06	0.01	0.17
Vigna unguiculata subsp. sesquipedalis (L.) Verdc.	Fabaceae	V	0.04	0.01	0.25
Arachis hypogaea L.	Fabaceae	H	3.85±0.08	3.33±0.08	0.86
Cassia alata L.	Fabaceae	H	0.42±0.01	0.38±0.01	0.90
Cassia obtusifolia L.	Fabaceae	H	1.22±0.03	1.04±0.02	0.85
Cassia uniflora Mill.	Fabaceae	H	1.38±0.03	1.20±0.03	0.87
Cassia tora L.	Fabaceae	H	1.30±0.03	0.87±0.02	0.67
Caesalpinia crista L.	Fabaceae	H	0.37±0.01	0.32±0.01	0.86
Indigofera tinctoria L.	Fabaceae	H	3.28±0.07	1.26±0.03	0.38
Crotalaria albida Heyne ex Roth	Fabaceae	H	0.42±0.01	0.37±0.01	0.88
Crotalaria pallida Aiton	Fabaceae	H	0.95±0.02	0.64±0.02	0.67
Crotalaria juncea L.	Fabaceae	H	0.74±0.02	0.64±0.02	0.86
Tephrosia apollinea (Delile) DC.	Fabaceae	H	1.77±0.05	0.55±0.01	0.31
Tephrosia purpurea (L.) Pers. (Sarponkh)	Fabaceae	H	1.56±0.04	1.16±0.03	0.74
Delonix regia (Bojer) Raf.	Fabaceae	T	0.38±0.01	0.29±0.01	0.76
Entada gigas (L.) Fawc. & Rendle	Fabaceae	V	1.88±0.04	0.27±0.01	0.14
Leucaena leucocephala (Lam.) de Wit.	Fabaceae	S	1.24±0.03	0.32±0.01	0.26
Mimosa pudica L.	Fabaceae	S	1.85±0.04	0.63±0.02	0.34
Parkia javanica Merr.	Fabaceae	T	0.99±0.02	0.91±0.02	0.92
Senna siamea (Lam.) H.S.Irwin & Barneby	Fabaceae	T	0.42±0.01	0.31±0.01	0.74
Juglans regia L.	Juglandaceae	T	0.18±0.01	0.15±0.01	0.83
Gmelina arborea Roxb. ex Sm.	Lamiaceae	T	0.19±0.01	0.12±0.01	0.63
Hyptis suaveolens (L.) Poit.	Lamiaceae	H	0.42±0.01	0.22±0.01	0.52
Leonotis nepetifolia (L.) R.Br.	Lamiaceae	H	0.35±0.01	0.23±0.01	0.66
Ocimum americanum L.	Lamiaceae	H	0.51±0.01	0.41±0.01	0.80
Ocimum sanctum L.	Lamiaceae	H	1.85±0.04	1.27±0.03	0.69
Ocimum tenuiflorum L.	Lamiaceae	H	0.58±0.02	0.43±0.02	0.74
Origanum vulgare L.	Lamiaceae	H	0.30±0.01	0.29±0.01	0.97
Tectona grandis L.f.	Lamiaceae	T	0.69±0.02	0.59±0.02	0.86

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Litsea glutinosa (Lour.) C.B.Rob.	Lauraceae	T	1.84±0.04	1.59±0.03	0.86
Linum usitatissimum L. (Alsi)	Linaceae	H	0.33±0.01	0.22±0.01	0.67
Linum usitatissimum L.	Linaceae	H	0.33±0.01	0.22±0.01	0.67
Strychnos Potatorum	Loganiaceae	T	1.07±0.02	0.96±0.02	0.90
Careya arborea Roxb.	Lecythidaceae	T	2.61±0.06	2.28±0.05	0.87
Lawsonia inermis L.	Lythraceae	T	1.99±0.04	1.09±0.02	0.55
Trapa natans L.	Lythraceae	H	1.60±0.04	1.36±0.03	0.85
Lagerstroemia parviflora Roxb.	Lythraceae	T	2.35±0.05	1.06±0.02	0.45
Azadirachta indica A.Juss.	Meliaceae	T	2.44±0.05	2.16±0.05	0.89
Melia azedarach L.	Meliaceae	T	3.50±0.08	3.13±0.07	0.89
Abelmoschus esculentus Moench	Malvaceae	H	0.50±0.01	0.44±0.01	0.88
Abelmoschus moschatus Medik.	Malvaceae	H	2.25±0.05	1.96±0.04	0.87
Abutilon indicum (L.) Sweet	Malvaceae	H	0.46±0.01	0.44±0.01	0.96
Corchorus olitorius L.	Malvaceae	H	0.42±0.01	0.31±0.01	0.74
Corchorus olitorius L. (White)	Malvaceae	H	0.77±0.02	0.67±0.02	0.87
Gossypium arboreum L.	Malvaceae	H	2.01±0.04	1.79±0.04	0.89
Hibiscus cannabinus L.	Malvaceae	H	0.84±0.02	0.73±0.02	0.87
Hibiscus sabdariffa L.	Malvaceae	H	0.51±0.01	0.39±0.01	0.76
Malachra capitata L.	Malvaceae	H	0.27±0.01	0.23±0.01	0.85
Sida acuta Burm.f.	Malvaceae	H	0.90±0.02	0.73±0.02	0.81
Sida cordifolia L.	Malvaceae	H	2.06±0.05	0.85±0.02	0.41
Sterculia foetida L.	Malvaceae	T	0.26±0.01	0.15±0.01	0.58
Sterculia urens Roxb.	Malvaceae	T	0.48±0.01	0.42±0.01	0.88
Thespesia populnea Sol. ex Corrêa	Malvaceae	T	2.51±0.05	2.20±0.05	0.88
Urena lobata L.	Malvaceae	V	0.38±0.01	0.32±0.01	0.84
Artocarpus heterophyllus Lam.	Moraceae	T	0.89±0.02	0.32±0.01	0.36
Ficus racemosa L.	Moraceae	T	0.48±0.01	0.41±0.01	0.85
Psidium guajava L.	Myrtaceae	T	0.30±0.01	0.21±0.01	0.70
Syzygium cumini (L.) Skeels	Myrtaceae	T	2.85±0.07	2.30±0.05	0.81
Moringa oleifera Lam.	Moringaceae	T	0.32±0.01	0.26±0.01	0.81
Nelumbo nucifera Gaertn. (Lotus)	Nelumbonaceae	H	2.60±0.05	0.43±0.01	0.17

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Passiflora foetida L.	Passifloraceae	H	3.62±0.06	3.17±0.06	0.88
Argemone mexicana L.	Papeveraceae	H	5.00±0.11	4.47±0.10	0.89
Papaver somniferum L.	Papeveraceae	H	4.31±0.09	3.89±0.08	0.90
Sesamum indicum L. (White)	Pedaliaceae	H	2.50±0.06	2.12±0.05	0.85
Sesamum radiatum Schumach. & Thonn. (Black)	Pedaliaceae	H	3.40±0.07	2.98±0.06	0.88
Sesamum radiatum Schumach. & Thonn. (Brown)	Pedaliaceae	H	4.75±0.09	4.29±0.08	0.90
Piper nigrum L.	Piperacee	H	1.95±0.04	1.66±0.04	0.85
Cleistanthus collinus (Roxb.) Hook.f.	Phyllanthaceae	T	2.21±0.06	0.68±0.02	0.31
Phyllanthus emblica L.	Phyllanthaceae	T	0.49±0.01	0.38±0.01	0.78
Bridelia retusa A.Juss.	Phyllanthaceae	T	4.00±0.09	3.13±0.07	0.78
Eleusine coracana Gaertn.	Poaceae	H	0.30±0.01	0.18±0.01	0.60
Hordeum vulgare L.	Poaceae	H	0.30±0.01	0.21±0.01	0.70
Oryza sativa L. (Sarna)	Poaceae	H	0.33±0.01	0.24±0.01	0.73
Oryza sativa L. (52-4)	Poaceae	H	0.31±0.01	0.21±0.01	0.68
Oryza sativa L. (Pashhar chawal)	Poaceae	H	0.29±0.01	0.21±0.01	0.72
Panicum sumatrense Roth ex Roem. & Schult.	Poaceae	H	0.36±0.01	0.25±0.01	0.69
Paspalum scrobiculatum L.	Poaceae	H	0.39±0.01	0.27±0.01	0.69
Pennisetum glaucum (L.) R.Br.	Poaceae	H	0.41±0.01	0.25±0.01	0.61
Setaria italica P.Beauv.	Poaceae	H	0.49±0.01	0.23±0.01	0.47
Sorghum bicolor (L.) Moench	Poaceae	H	0.42±0.01	0.22±0.01	0.52
Triticum aestivum L.	Poaceae	H	0.39±0.01	0.19±0.01	0.49
Zea mays subsp. *mays*	Poaceae	H	0.45±0.01	0.26±0.01	0.58
Persicaria punctata Small	Polygonaceae	H	1.91±0.04	0.77±0.02	0.40
Putranjiva roxburghii Wall.	Putranjivaceae	T	0.49±0.01	0.26±0.01	0.53
Nigella sativa L.	Ranunculaceae	H	4.25±0.10	3.75±0.08	0.88
Ziziphus mauritiana Lam.	Rhamnaceae	T	1.28±0.03	1.07±0.03	0.84
Anthocephalus indicus A.Rich.	Rubiaceae	T	1.42±0.03	0.57±0.02	0.40
Gardenia thunbergia Thunb.	Rubiaceae	S	0.61±0.02	0.35±0.01	0.57
Prunus dulcis (Mill.) D.A.Webb	Rosaceae	T	0.60±0.02	0.27±0.01	0.45
Aegle marmelos Corrêa	Rutaceae	T	1.90±0.04	1.53±0.04	0.81

Table S1 continued..

Species	Family	Type	Concentration		Fla/TPh
			TPh	Fla	
Citrus limon (L.) Burm.f.	Rutaceae	S	0.57±0.02	0.51±0.02	0.89
Citrus sinensis (L.) Osbeck	Rutaceae	S	0.66±0.02	0.38±0.01	0.58
Murraya koenigii Spreng.	Rutaceae	S	2.93±0.06	2.52±0.06	0.86
Cardiospermum halicacabum L.	Sapindaceae	V	0.78±0.02	0.28±0.01	0.36
Litchi chinensis Sonn.	Sapindaceae	T	2.04±0.04	0.41±0.01	0.20
Sapindus emarginatus Vahl.	Sapindaceae	T	0.34±0.01	0.29±0.01	0.85
Schleichera oleosa (Lour.) Oken	Sapindaceae	T	2.44±0.05	2.2±0.05	0.90
Santalum album L.	Santalaceae	T	1.48±0.03	1.07±0.02	0.72
Manilkara zapota (L.) P.Royen	Sapotaceae	T	1.85±0.05	1.39±0.03	0.75
Madhuca indica J.F.Gmel.	Sapotaceae	T	2.32±0.06	1.17±0.03	0.50
Mimusops elengi L.	Sapotaceae	T	0.28±0.01	0.27±0.01	0.96
Illicium verum Hook.f.	Schisandraceae	H	1.32±0.03	0.57±0.01	0.43
Capsicum annuum L. (Small Mirch)	Solanaceae	H	0.46±0.01	0.32±0.01	0.70
Capsicum annuum L. (Medium Mirch)	Solanaceae	H	0.42±0.01	0.32±0.01	0.76
Datura stramonium L.	Solanaceae	H	0.94±0.02	0.51±0.01	0.54
Solanum lycopersicum L.	Solanaceae	H	1.30±0.03	1.08±0.02	0.83
Solanum melongena L. (White)	Solanaceae	H	0.73±0.02	0.45±0.01	0.62
Solanum melongena L. (Purple)	Solanaceae	H	0.87±0.02	0.77±0.02	0.89
Solanum melongena L. (Green)	Solanaceae	H	0.52±0.01	0.46±0.01	0.88
Solanum melongena L. (Singhi)	Solanaceae	H	0.68±0.02	0.47±0.01	0.69
Solanum virginianum L.	Solenaceae	H	2.12±0.05	0.68±0.02	0.32
Withania coagulans Dunal	Solanaceae	H	0.94±0.02	0.64±0.02	0.68
Withania somnifera (L.) Dunal	Solanaceae	H	0.84±0.02	0.51±0.01	0.61
Lantana camara L.	Verbenaceae	H	0.61±0.02	0.27±0.01	0.44

T = tree, S = shrub, H = herb, V = vine.

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