Botanical Characters and Phytochemical Properties of the Flowers of *Madhuca longifolia* (J.Koenig ex L.) J.F.Macbr.

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Abstract

Background: *Madhuca longifolia* belonging to family Sapotaceae is abundantly grown in Mandalay Region. The flowers of this plant are edible and traditionally used as diuretics, tonic, and for heart diseases and better health and longevity. So, this study was carried out to examine the morphological and phytochemical characters and nutritive value of its flowers which was collected during March 2018 to May 2019.

Methods: The plant specimen collected from Yadanabon University Campus was identified and documented its morphological characters. The preliminary phytochemical screening of flower powder was tested and the chemical nutrients of flower were also determined by using method mentioned in A.O.A.C, 2000. Quantitative elemental analysis of flower sample was carried out.

Results: *Madhuca longifolia* was a deciduous tree; leaves simple; inflorescences axillary and fascicles: flowers bisexual; fruits ellipsoid. All test compounds were present in its flower except for steroid, starch and cyanogenetic glycoside. The content of protein, and carbohydrates was high in flower sample. The contents of calcium, potassium iron and zinc were detected and calcium, chlorine and potassium contents were found to be the highest.

Conclusion: The results of this research indicated that flowers of *M. longifolia* are very nutritious and healthy food for human. Isolation, purification and identification of new bioactive compounds from flowers as well as other parts of this plant are required as it may help further to establish the application of isolated compound in treatment of various diseases.

Key words: *Madhuca Longifolia*, morphology, macroscopic characters of flower powder, relative composition of elements

Introduction

According to WHO (2003) approximately 65% of the world's population integrate the medicinal plant for treatment. They are having a great importance to pharmaceutical industry, because these are rich sources of drugs and a vast reservoir of chemical diversity for screening programs aimed at new drug diversity. Most of the drugs which are mentioned in the Myanmar medicinal system are from plant sources.

Madhuca longifolia belongs to the Family Sapotaceae and is commonly known as Indian butter tree; Mahua butter tree in English, mahua in India and Me-zae; Myintzu-thetka-natpan; Kan-zaw in Myanmar. *M. longifolia* originated from India, Sri Lamka, Nepal and Myanmar (Fern, 2014). *M. longifolia* is a medium-size and deciduous tree which is much branched. The leaves are alternate, simple, oblong-shaped and young leaves are pinkish, reddish-brown. Flowers live only one night and then fall to the ground. Fruits are greenish ovoid containing 1- 4 shiny, oily brown seeds (Dassanayake, 1997; Trees India, 2016; Fern, 2014).

Flowers of this plant are edible, and have high nutritive value majorly high amount of sugars and subsequently have good amount of vitamins, proteins, minerals and fats (Patel et. al., 2011). In Indian system of medicine (The Ayurveda), the flowers of Mahua are reported to be cooling, aphrodisiac, galactagogue and carminative. They are also reported to be beneficial in heart diseases, burning sensation and ear complaints (Patel et. al., 2008). *Mahua* flowers contain good

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amount of Vitamin-C which is responsible for its antioxidant activity (Indu et. al. 2014). In Myanmar, its flowers are used as tonic, appetizer, stimulant and dried flowers are boiled with water or mixed with honey to cure heart disease, cough and is drunk as tea for healthy and longevity and also sold as dry flower in famous area of Mandalay Region.

The present study was undertaken to identify the Mahua plant, to examine the morphological and phytochemical characters and nutritive value of its flowers and to provide the useful information for further pharmaceutical and economical study.

Materials and Methods

1. Botanical Studies

The fresh specimen of studied plant was collected from Yadanabon University Campus, Amarapura Township, Mandalay Region during the flowering period from December 2017 to May 2019. The collected plant materials were identified with the help of available literatures (Backer, 1965; Hooker, 1897; Dassanayake, 1997; Trees India, 2016; Fern, 2014). Morphological characters of studied plant were also documented. The flowers were air-dried and then ground to form powder and stored in air-tight containers for further investigation.

2. Chemical studies

2. 1. Preliminary phytochemical screening of *M. longifolia* flowers

The preliminary phytochemical screening of the flower samples of *M. longifolia* had been performed according to Trease and Evans (2002); central council for research in Unani medicine (1987), Marine-Bettolo G.B. el al, (1981).

2.2 Determination of Chemical Nutrients of *M. longifolia* flowers

Moisture content, ash content, protein content, crude fiber content, crude fat content, carbohydrate content and energy value of *M. longifolia* were determined using methods in A.O.A.C, 2000.

2.3 Elemental Analysis of flower sample by ED-XRF

Semi-quantitative estimation of metals in collected flower samples of *M. longifolia* was determined by X-ray Fluorescence Spectrometer at Chemistry Department, West Yangon University.

2.4. Quantitative Elemental Analysis by Atomic Absorption Spectrometry (AAS)

About 0.5 g of flower ash sample of *M. longifolia* was accurately weighed and dissolved in 2ml of concentrated hydrochloric acid solution. The resulting solution of ash sample was evaporated to dryness and dissolved in 6ml of 25% HCl solution by centrifugation. The resultant solution (10ml) was pipette accurately and made up to 100ml with deionized water again. The sample solution prepared was now ready for analysis of mineral element by AAS at Chemistry Department, West Yangon University.

Results

1. Botanical Studies

1.1 Morphological characters

***Madhuca longifolia* (J.Koenig ex L.) J.F.Macbr., Contr. Gray Herb., n.s., 53:17 1918.**

Bassia longifolia J.Koeing ex L., Mant. Pl. 2(App.): 563 (1771)

Madhuca longifolia var. *longifolia*

Vidoricum longifolium (J. Koenig ex L.) Kuntze

Family name – Sapotaceae

English name – Indian Butter Tree; Mahua butter tree

Myanmar name – Me-zae; Myintzu-thetka-natpan; Kan-zaw
Flowering and fruiting period – April to May

A large much-branched deciduous trees; young stems and branches sparsely pubescent or glabrescent; bark blackish, glabrous. Leaves simple, alternate, usually crowded at the tips of branches; stipules linear-lanceolate, pubescent, caducous; petioles pubescent; blades oblanceolate or elliptic-lanceolate to oblong, 5.0-10.5 cm x 1.0-3.5 cm, coriaceous, cuneate at the base, entire along the margin, acute at the apex, glabrous. Inflorescences axillary and fascicles cyme with 10-15 flowers. Flowers pale yellow, bisexual, actinomorphic, hypogynous, pungently fragrant, bracteates, ebracteolate; pedicels tomentose, persistent; calyx 2+2 in two series, aposepalous, linear – ovate, tomentose; corolla 8 (7-10) -lobed, pale yellow, synpetalous, urceolate, glabrous; tubes inflated; lobes elliptic oblong; stamens 8, free, petalostamonous; filaments adnate to the throat of corolla tube, hairy; anthers dithecous, oblongoid, basifixed, dehiscence by longitudinal slits; Ovary oblongoid,

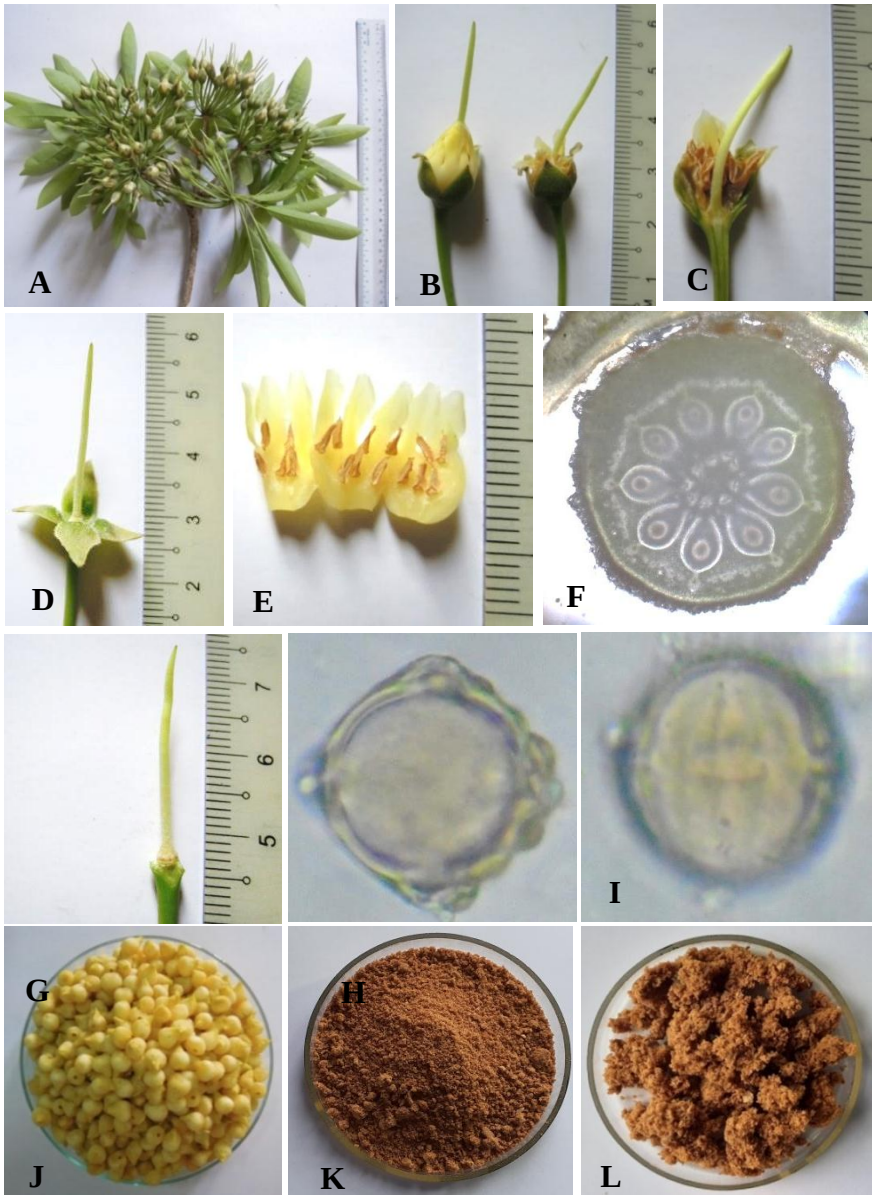

Figure 1 Morphological and Pollen Characters of ***M. longifolia***
(A) Inflorescence (B) Flower as seen (C) L.S flower
(D) Sepals with carpel (E) Petal with stamens (F) T.S ovary

(G) Gynoecium (H) Pollen (Equatorial view) and (I) Pollen (Polar view)
(J) Fresh flowers (K) and (L) Dried flower powder

8-locular, with one ovule in each locule on the axile placentae; styles terminal, exerted, densely rust pubescent, persistent; stigma simple. Fruits berry, ellipsoid, 3.0-3.5 cm x 1.5-2.5 cm, yellow, glabrous, one or two seeded. Seeds about 0.5 cm long, brown, ellipsoid, with long raphe, rich in fats, shining brown (Figure 1).

Specimen examined – Yadanabon University Campus, Mandalay Region, N 21˚ 59′ 20.4″ and E 96˚ 09′ 25.7″: 6 April, 2018.

Table 1 Macroscopic characters of *M. longifolia* flower powder

characters	Result
Color	Yellowish Brown
Odour	fragrant
Taste	Sweet
Texture	Granular and sticky

Pollen Characters of *M. longifolia*

Monads, tetra-pentacolporate, isopolar, prolate spheroidal, medium, 37.5-45.0 x 32.5-42.5 µm in length and breadth; amb circular; colpi longicolpate, 22.5-32.5 x 2.5-5.0 µm in length and breadth; pori lalongate, 2.5-5.0 x 5-10 µm in length and breadth; exine 1.25-2.50 µm thick, sexine thicker than nexine; sculpturing psilate (Figure 1).

2. Chemical Studies

2.1 The preliminary phytochemical screening of *M. longifolia* flower

The preliminary phytochemical screening was carried out on the powdered flowers. This test indicated that the flowers contained alkaloid, Carbohydrate, glycoside, phenol, amino acid, saponin, tannin, reducing sugar, terpenoid and flavonoid. The absence of starch, steroid and cyanogenic glycoside were recorded (Table 2).

Table 2 Preliminary phytochemical phytochemical screening of *M. longifolia* flower

No.	Type of compound	Extract	Reagent used	Observation	Results
1.	Alkaloid	1%HCL	Mayer's reagent	Cream olour ppt.	+
			Wagner's reagent	Brown ppt.	
			Dragendorff 's reagent	Orange ppt.	
			Hager's reagent	Yellow ppt.	
2.	Carbohydrate	H_2O	10% α -naphthol & H_2SO_4 (Conc:)	red ring	+
3.	Glycoside	H_2O	10% Lead acetate solution	White ppt.	+
4.	Phenol	H_2O	5% $FeCL_3$ solution	Brownish green colour	+
5.	α-amino acid	H_2O	Ninhydrin reagent	Pink colour	+
6.	Saponin	H_2O	H_2O	Persistent foam	+
7.	Tannin	H_2O	1% Gelatin & 10% NaCL solution	ppt.	+
8.	Flavonoid	70%EtOH	Mg ribbon & Conc; HCL	Red colour.	+
9.	Steroid	Petroleum ether	Acetic anhydrite & Conc; H_2SO_4	-	-
10.	Terpenoid	Petroleum ether	Acetic anhydrite & Conc; H_2SO_4	Pink	Trace
11.	Reducing sugar	H_2O	Fehling's solution	Brick red ppt.	+
12.	Starch	H_2O	Iodine solution	Brown ppt.	-
13.	Cyanogenic	powder	H_2O, Conc: H_2SO_4,	No colour change	-

	glycoside		sodium picrate paper		

(+) = presence (-) = absence

Table 3 Physicochemical parameters of flowers of *M. longifolia*

Parameters	Values obtained (%w/w)
Moisture content	17%
Total Ash value	0.184%
Water soluble ash	0.080%
Alcohol soluble extractive	0.680%
Water soluble extractive	0.664%

2.2 Determination of Chemical Nutrients found in *M. longifolia* flower

As a result, *M. longifolia* flower was found that the amount of carbohydrates and protein was highest in flower samples, and fat, fibre calcium, phosphorus and iron are also found. The results are shown in Table 4.

Table 4 Comparative nutitional constituents of mahua *M. longifolia* flowers with other fruits

Per 100g	Apple	Mahuaflower (Ripe)	Banana	Mango	Mahua flower(Dry)		Raisins
					result	literature	
Moisture*	84.6	73.6	70.1	81	**5.28**	11.61	20.2
Protein*	0.2	1.4	1.2	0.6	**6.96**	6.67	1.8
Fat*	0.5	1.6	0.3	0.4	**0.39**	0.09	0.3
Minerals*	0.3	0.7	0.8	0.4	**-**	-	2
Ash	-	-	-	-	**4.59**	4.36	-
Fibre*	1	-	0.4	0.7	**3.25**	1.9	1.1
Carbohydrates*	13.4	22.7	27.2	16.9	**79.53**	68	74.6
Energy (Kcal)	59	111	116	74	**352**		308
Calcium**	10	45	17	14	**250**	139	87
Phosphorus**	14	22	36	16	**115**	137	80
Iron**	0.66	0.23	0.36	1.3	**45**	-	7.7
Carotene (µg)	0	307	78	2743	-	-	2.4
Thiamine**	-	-	0.05	0.08	-	0.028	0.07
Riboflavin**	-	-	0.08	0.09	-	0.87	0.19
Niacin**	0	-	0.5	0.9	-	4.8	0.7
Vitamin C**	1	40	7	16	-	-	-
Choline**	321	-	-	-	-	-	-

*-g/100g, **-mg/100g

Source: Nutritive value of Indian foods, National Institute of Nutrition, Hyderabad[12]

Source: Jayasree et. al.[16]

2.3 Relative Abundance of Some Elements in *M. longifolia* flower sample

The result of relative compositions of elements in the flower samples was determined by Energy Dispersive X-ray Fluorescence Spectrometer that is shown in Table 4. The calcium, sulphur, potassium, phosphorus and iron contents were found to be highest and manganese. Silver, strontium and zinc contents were found to be lowest.

2.4 Elemental Analysis of the *M. longifolia* flower samples by AAS

Quantitative elemental analyses of the samples were determined by AAS (Atomic Absorption Spectrometry) method. In this work, some selected heavy metals were detected. The results are shown in Table 5 and figure 5.

Table 4 Relative Abundance of Some Elements in *M. longifolia* flower sample

No.	Element	Relative Abundance (%)
1.	K	0.861
2.	Ca	0.250
3.	S	0.131
4.	P	0.115
5.	Fe	0.045
6.	Ti	0.007
7.	Ag	0.003
8.	Zn	0.002
9.	Mn	0.002
10.	Sr	0.001
11.	COH	98.582

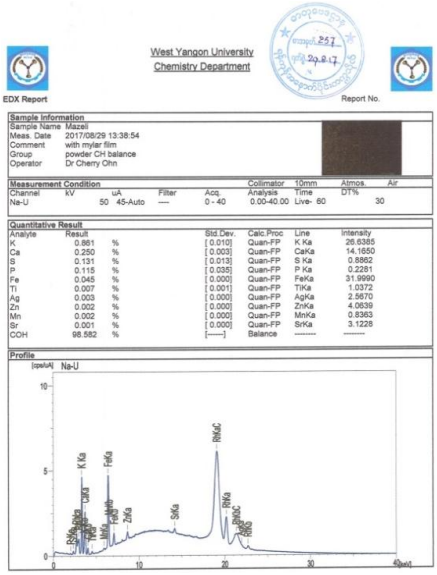

Figure 4 Relative Abundance of Some Elements in *M. longifolia* flower sample

Table 5 Quantitative Elemental Analysis Data of *M. longifolia* by AAS

No.	Element	Sample (ppm)
1.	Pb	0.062
2.	Cd	0.012
3.	Fe	12.97
4.	Zn	0.452
5.	As	3.826

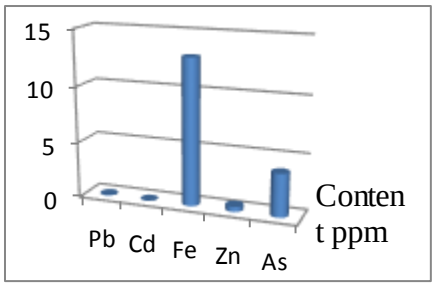

Figure 5 Quantitative Elemental Analysis of *M. longifolia* flower by AAS

Table 6: Traditional medicinal uses of *M. longifolia* flowers (Local uses and Literature uses)

Medicinal Uses[1]	Medicinal Uses[2]	Way of consumption[1]	Way of consumption[2]	References
Used as tonic	to be healthy and longevity	Flower mixed with honey/drink flower tea	Flower juice	Mishra and Pradhan, (2013)[17]; Amia and Ekka, (2014)[3]; Sinha *et al.*, (2017)[21]
Heart disease	Cure heart disease	Flower mixed with honey and butter	Flower	Kirtikar, & Basu (1953)[16]
Stimulant	Cure skin diseases	Flower mixed with honey	Flower juice	Amia and Ekka, (2014)[3]; Sinha *et al.*, (2017)[21]
	Cure eye diseases		Flower juice	Amia and Ekka, (2014)[3]
	Cure Raktapitta		Flower juice	Sinha *et al.*, (2017)[21]
	cure headache		Flower juice	Sinha *et al.*, (2017)[21]
Astringent	cure diarrhoea and colitis	Flower powder	Flower powder	Amia and Ekka *et al.*, (2014)[3]; Sinha *et al.*, (2017)[21]
	increases lactation		Raw flowers	Mishra and Pradhan, (2013)[17]; Sinha *et al.*, (2017)[21]
Cough	Cure cough and bronchitis	Roasted flowers	Roasted flowers	Palani *et al.*, (2010)[18]; Mishra and Pradhan, (2013)[17]; Sinha *et al.*, (2017)[21]
	Cure impotency and general debility		Flower mixed with milk	Acharya and Shrivastava, (2008)[1]; Amia and Ekka, (2014)[3]
	cure piles		Flowers fried in ghee	Palani *et al.*, (2010)[18]; Mishra and Pradhan, (2013)[17]; Sinha *et al.*, (2017)[21]

[1]Myanmar traditional uses [2]Literature cited

Discussion and Conclusion

Madhuca longifolia was deciduous tree and the leaves are simple, stipulate, leaves blade oblanceolate or elliptic lanceolate, glabrous. Inflorescences axillary fasciculate cyme: flower bisexual, pungently fragrant, bracteates; calyx 2+2, aposepalous; corolla 8 (7-10) lobed; stamens 8, petalostamonous, anther basifixed; ovary 8 locular; fruit ellipsoid with one or two oily seeds. These characters were consistent with those mentioned by Backer (1965), Hooker (1897), Dassanayake (1997), Trees India (2016) and Fern (2014).

The flowers of *M. longifolia* consisted of alkaloid, Carbohydrate, glycoside, phenol, amino acid, saponin, tannin, reducing sugar, terpenoid and flavonoid except for steroid, starch and cyanogenetic glycosides which are agreement with those reported by Patel et. al., (2008) and Sinha et. al.,(2017). Chemical Nutrients found in *M. longifolia* was carbohydrates, protein that is highest in flower samples, and fat, fibre calcium, phosphorus and iron are also found. Whenever human flex their muscles every time and blink their eyes, they are using potassium; calcium is important in building and maintaining strong bones and teeth; phosphorus is next important to calcium as utilization of calcium is closely related to it. The regular contractions of the heart are dependent upon phosphorus, as are normal cell growth and repair. Iron is used by the body to make tendons and ligaments (website 1). It can be found that the *M. longifolia* flowers have these predominant elements which are very effective to human health. The nutritional values of the flower give the good supplemental nutrients to human. Moreover, the nutritive value of these flowers is higher than those of other fruits. It is expected that *M. longifolia* flower may be one of the potential sources for nutritional feeding to living things.

According to scientists, medicines obtained from medicinal plants are best alternative to combat the diseases, as they have immense potentials to treat the diseases with least side effect and with high safety and efficacy (Dhruv et. al., 2018). *M. longifolia* is one of most important plants which has been used for medicinal as well as for household purposes. Flowers of this plant have been used in the prevention and treatment of diseases like heart disease and cough and as stimulant, astringent, appetizer and tonic for healthy and longevity in Myanmar and according to Acharya and Shrivastava, (2008); Amia and Ekka, (2014); Palani *et al.*, (2010); Mishra and Pradhan, (2013); Sinha *et al.*, (2017), it also has pharmaceutical potential for curing eye disease, skin disease, headache, diarrhoea and colitis and; as cooling agent to cure piles and galactagogue.

The flowers of *M. longifolia* are traditionally used Mahua flower that is proved as a suitable substrate for large scale production of ethanol, since it consists of high sugars 68 % and metal ions such as Mg+, Cu+, phosphorous and protein Benerji et al. (2010). It is a cheapest raw material that can be obtained from any part of central Myanmar. The flowers of *M. logifolia* can be used as suitable raw material for large scale production of ethanol in Myanmar.

In this research, morphology and phytochemistry aspects of *M. longifolia* have been highlighted. Further exhaustive work is required, because the literature shows limited research in several areas to understand and reveal the mode of its pharmacological activities. In addition, isolation, purification and identification of new entities from flowers as well as other parts of this plant are required as it may help further to establish the application of isolated compound in treatment of various diseases.

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