Search Feedipedia Search

Automatic translation
Anglais

Feed categories
All feeds
drilling plants
- Cereal and grass forages
- Legume forages
- Forage trees
- Aquatic plants
- Other forage plants

Plant products/by-products
- Cereal grains and by-products
- Legume seeds and by-products
- Oil plants and by-products
- Fruits and by-products
- Roots, tubers and by-products
- Sugar processing by-products
- Plant oils and fats
- Other plant by-products

Feeds of animal origin
- Animal by-products
- Dairy products/by-products
- Animal fats and oils
- Insects

Other feeds
- Minerals
- Other products

Latin names
Plant and animal families
Plant and animal species

Resources
Broadening horizons
Literature search
Image search
Glossary
External resources
- Literature databases
- Feeds and plants databases
- Organisations & networks
- Books
- Journals

Mahua (Madhuca longifolia)

Description | Nutritional aspects | Nutritional tables | References

Click on the "Nutritional aspects" tab for recommendations for ruminants, pigs, poultry, rabbits, horses, fish and crustaceans




Common names

Mahua, Mahwa, Mohwa, mohwra, llupai, tree honey, butter tree [English]; illipe, shea tree, shea, Madhuca [French]; [Bengali]; [Burmese]; [Gujarati]; [Hindi] [Kannada]; [Malayalam]; [Marathi]; [Nepali]; [Punjabi]; [Tamil] [Telugu]

Products: mahua seed cake, mahua oil cake

Species

Madhuca longifolia (L.) J. F. Macbr. [Sapotaceae]

Synonyms

Madhuca indica J. F. Gmel, *Madhuca latifolia* (Roxb.) J. F. Macbr, *Illipe latifolia* (Roxb.) F. Muell., *Bassia longifolia* L., *Bassia latifolia* Roxb.

Taxonomic information

Mahua is sometimes used for *Diploknema butyracea* (Roxb.) H. J. Lam a related species with similar properties that was formerly known as *Madhuca butyracea* (Roxb.) J. F. Macbr.

Feed categories

- Toxic plants
- Oil plants and by-products
- drilling plants
- Other forage plants

Related feed(s)

Description

Mahua (*Madhuca longifolia* (L.) J. F. Macbr.) is a multipurpose tropical tree mainly cultivated or harvested in the wild in South Asia for its edible flowers and oil seeds (CJP, 2007; Fern, 2014; Orwa et al., 2009).

Morphology

Mahua is a medium-size, deciduous tree, up to 16-20 m high. It has a short, stout trunk, 80 cm in diameter. The crown is rounded, much branched. The bark is grey, vertically cracked and wrinkled, exfoliating in thin scales. The leaves are alternate clustered at the end of branchlets. The leaf blade is simple, 10-25 cm long x 6-12 cm broad, oblong-shaped, rigid, thick and firm, wooly at the lower face and exudating a milky sap when broken. Young leaves are pinkish, reddish-brown. Flowers are borne on green or pink, furry bunches, each bunch consisting of 12 fragrant cream-coloured flowers. The flowers live only one night and then fall to the ground. Pollinated flowers develop into a fleshy, greenish ovoid fruit containing 1-4 shiny, oily brown seeds. The seeds are 3-5 cm long, elliptical, flattened on one side (Trees India, 2016; FOI, 2016; Fern, 2014; Orwa et al., 2009).

Uses

Mahua flowers, fruits and leaves are edible and used as vegetables in India and other South Asian countries. The sweet, fleshy flowers are eaten fresh or dried, powdered and cooked with flour, used as sweetener or fermented to make alcohol (Fern, 2014). The fleshy outer coat of the fruit is used as a vegetable. In India, during periods of scarcity, a combination of mahua flowers and sal seeds (*Shorea robusta*) is boiled to prepare a substitute for grain staples (Sunita et al., 2013). Mahua is an oil plant whose seeds yield between 35 and 47% oil (CJP, 2007; Ratnabhargavi, 2013). Mahua oil is used to make soaps and candles and is a treatment against pest infestations in seeds (Orwa et al., 2009). Oil produced in smallholder farms is of low quality and is mainly used as a ghee substitute or adulterant (Fern, 2014). Mahua oil was reported to have potential use in biodiesel production. In India, potential mahua oil production could be up to 60 million t/year (CJP, 2007). The oil cake resulting from oil extraction is used as a fertilizer, and could be used to control root-knot nematode and fungal infections as the high saponin content reduces nematodes and phytopathogenic fungi (Gupta, 2013; Orwa et al., 2009). Mahua trees host *Antheraea paphia,* the tassar silkworm which produces silk traditionally used in sari (Vantomme, 2002). Mahua is also used for its hard, strong, dense and reddish timber (Orwa et al., 2009). Mahua flowers produce a nectar that is very valuable to honey bees in periods of scarcity (Singh et al., 2008). Mahua is reported to have many applications in traditional medicine, and to provide several environmental services (see **Environmental impact** below).

Several mahua products are used to feed livestock. Leaves, flowers and fruits are lopped to feed goats and sheep (Singh et al., 2008). The mahua oil cake (usually called mahua seed cake in India) is used for ruminants in areas where mahua oil production is important, but is generally considered detrimental to livestock performance due to its high content in saponins (Singhal et al., 1986). Spent flowers, the by-product alcohol production, are another by-product of mahua that is occasionally fed to livestock (Reddy et al., 1966).

Distribution

Mahua originated from Asia: India, Sri Lanka, Nepal and Myanmar (Fern, 2014). Mahua is a frost resistant species that can grow in marginal areas of dry tropical and subtropical forests up to an altitude of 1200-1800 m, in India. It can be found scattered in pastures and crop fields in central India, and on rivers banks in semi-evergreen forests (Trees India, 2016; Orwa et al., 2009). It grows well in places where annual rainfall ranges from 500 mm to 1500 mm, and where temperatures are in the range of 2-46°C. Mahua does better on deep loamy or sandy-loam soils with good drainage, it also occurs on shallow stony, clayey and calcereous soils (Orwa et al., 2009).

Processes

Oil extraction

Mahua seeds contain up to 50% oil. In the industrial extraction process, the seeds are first broken and flaked, the resulting flakes are steam-cooked and the cooked flakes are crushed and solvent-extracted with hexane at 63°C. The resulting mahua oil meal contains less than 1% oil. In smallholder farms, the seeds are only crushed, resulting in a energy-rich mahua seed cake containing up to 17% oil (Ratnabhargavi, 2013; Singhal et al., 1986).

Detoxification

Due to the low palatability and toxicity of mahua seed cake, there have been many attempts at improving its nutritional value. The most promising seems to be water washing, which was tested more or less successfully in ruminants and poultry (Singh et al., 1986).

drilling management

Mahua trees are vegetatively propagated. Scions from the mother plant are grafted on 1 year-old seedlings in July and are planted in September at 8 m spacing intervals. Mahua respond positively to N, P, K fertilizers. The trees start bearing fruits 10 years after plantation and can yield fruits for 60 years. Old trees are more productive than young trees. Irrigation may be useful during fruit development but should be avoided during flowering and leaf shedding. Fruits are harvested in May, June and July in India. Seed yield ranges from 60 to 80 kg/tree/year. Mahua trees are also harvested for their flowers and yield 100 to 150 kg of flower DM/tree/year (Singh, 2016).

Environmental impact

Soil improver, soil reclamation and erosion control

Though not a legume, mahua develops micorrhizal associations able to fix atmospheric N. Its extensive superficial root system binds the soil and limits erosion. Mahua was used in soil reclamation on hard lateritic soils in India. Fallen leaves on the soil provide organic matter but they do not break down as easily as other leaves like teak leaves or *Shorea robusta* leaves (Bargali et al., 2015; Manna et al., 2004). Mahua seed cake is used as a fertilizer and a root-knot nematode controller (Orwa et al., 2009; Yadav et al., 2005).

datasheet citation

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All feeds
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- Cereal and grass forages
- Legume forages
- Forage trees
- Aquatic plants
- Other forage plants

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- Legume seeds and by-products
- Oil plants and by-products
- Fruits and by-products
- Roots, tubers and by-products
- Sugar processing by-products
- Plant oils and fats
- Other plant by-products

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- Animal by-products
- Dairy products/by-products
- Animal fats and oils
- Insects

Other feeds
- Minerals
- Other products

Latin names
Plant and animal families
Plant and animal species

Resources
Broadening horizons
Literature search
Image search
Glossary
External resources
- Literature databases
- Feeds and plants databases
- Organisations & networks
- Books
- Journals

Mahua (Madhuca longifolia)

Description | Nutritional aspects | Nutritional tables | References

Nutritional attributes

Mauha seed cake

Mahua seed cake is relatively rich in protein (16-29%), the solvent-extracted meals being richer. Press cake contains about 5-17% oil while solvent-extracted meal contains usually less than 2% oil. The crude fibre content is generally low, from 3 to 12%.

Mahua spent flowers

The composition of mahua spent flowers shows considerable variation: samples collected from 3 areas in India contained 4-12% crude protein, 2-45% crude fiber, 2-8% ether extract and 4-11% ash (Reddy et al., 1966).

Potential constraints

Saponins

Mahua contains high levels of saponins, which reduce palatability and have antinutritional and toxic effects on animals, though less so in ruminants (EFSA, 2009). Mahua seed cake containing 5-6% saponins and fed to rats at 10-12% of the diet caused 100% rats mortality within a month (Mulky, 1976 cited by Shanmugasundaram et al., 1985). The oral LD50 in mice of crude *Madhuca* saponins was about 1.0 g/kg body weight. In mice and rats, *Madhuca* saponins caused local gastro-intestinal toxicity as well as liver and kidney toxicity. At lower doses, they are responsible for feed refusal and starvation, with reduced body weight gain and increased mortality (EFSA, 2009). Toxicity studies on monogastric animals are scarce. In chicks, it was reported that mahua seed cake included at approximately 12% of the diet was lethal (EFSA, 2009).

tannins

Mahua seed cake contains tannins that affect negatively its utilisation in livestock feeding (Singhal et al., 1986).

ruminants

In India, mahua trees are abundant in certain areas. Farmers collect the leaves, flowers and fruits to feed goats and sheep, and use mahua seed cake, flowers and spent flowers to feed cattle (Reddy et al., 1966; Singhal et al., 1986; Sunita et al., 2013).

Mahua seed cake

Mahua seed cake is generally considered as a poor feed ingredient for ruminants with a negative impact of protein digestibility and performance (Singhal et al., 1986). However not all results are negative and in some cases ruminants can tolerate water-washed mahua seed cake at inclusion rates up to 20% of the total diet (EFSA, 2009).

Palatability

The palatability of unprocessed mahua seed cake was found to be very poor but improved notably after a period of adapatation (Singhal et al., 1986).

Dairy cattle

In lactating Murrah buffaloes, processed mahua seed cake was incorporated into the concentrate mixture to replace groundnut cake at 0, 25, 50, 75 and 100%. DM intake and nutrient digestibility did not differ between the 5 treatments. Milk fat, solids-corrected milk and solids-not-fat yields, percentage of fat, lactose, ash and total solids, and gross energy values of milk did not differ between the 5 groups (Tiwari et al., 1997).

Growing cattle

Using mahua seed cake for feeding cattle and buffaloes was reported in tribal areas of Gujarat, India, in the late 1970s. These animals never showed lower feed consumption, adverse effects on productivity or symptoms of toxicity, which may signify that some adaptation was occurring. Indeed, in a 2-year experiment on growing calves, mahua seed cake did not affect growth. However, many trials have reported that animals fed mahua seed cakes had generally lower performance than the ones fed a control diet (Singhal et al., 1986). 12-14 month-old crossbreed calves fed a complete diet containing 20% of mahua seed cake had higher weight gain but lower crude protein digestibility than the control (EFSA, 2009). In male buffaloes, solvent-extracted mahua seed cake either alone or in combination with harad seed pulp (*Terminalia chebula*) was evaluated for its antimethanogenic activity. The intake digestibility of nutrients and energy utilization were not altered with mahua seed cake (Inamdar et al., 2015).

Mahua flowers and spent flowers

Mahua flowers are fleshy and sweet and have been used by Indian villagers to feed their cattle (Reddy et al., 1966). Spent flowers (the by-product of fermentation) are also used as animal feed. They are palatable to cattle and no adverse effect on milk yield and milk composition has been observed (Singhal et al., 1986).

Poultry

Mahua seed cake

Untreated mahua seed cake is toxic to chickens because of its high saponin content. In young chicks, high mortality was observed with high (35%) levels of mahua in the diet (Mukherjee et al., 1966). After removing saponins by water extraction, mahua seed cake still reduced feed consumption and growth performance of broilers, even at 5% of the diet (Dular et al., 2000). Unless an appropriate detoxification process is found, the use of mahua seed cake in poultry is not recommended.

Mahua spent flowers

Spent flowers fom alcohol production could be used to feed broilers and maintained performance without adverse effects at up to 8% (Reddy et al., 1966).

Rabbits

No studies have been conducted on rabbits (EFSA, 2009).

Horses and donkeys

No studies have been conducted on horses (EFSA, 2009).

Fish

Mahua seed cake cannot be used for fish feeding. In fact, due to the stupefying effect of saponins on fish (Murthy et al., 2010), mahua seed cake is traditionally used in India as a stupefiant for catching fish in ponds. 0.5 kg of mahua seed cake boiled in water can catch all fish in in 3 x 3 m pond (Kamalkishor et al., 2009).

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Mahua (Madhuca longifolia)

Description | Nutritional aspects | Nutritional tables | References

Tables of chemical composition and nutritional value

- Mahua (Madhuca longifolia), seed cake, mechanical extraction
- Mahua (Madhuca longifolia), seed cake, solvent-extracted
- Mahua (Madhuca longifolia), leaves, fresh

Avg: average or predicted value; SD: standard deviation; Min: minimum value; Max: maximum value; Nb: number of values (samples) used

Mahua (Madhuca longifolia), seed cake, mechanical extraction

Main analysis	Unit	Avg	SD	me	Max	Nb
Dry matter	% as fed	92.2				1
Crude protein	% DM	19.7	5.4	16.0	29.0	6
Crude fibre	% DM	6.5	3.8	3.1	12.6	6
Ether extract	% DM	8.3	2.4	5.0	10.9	6
Ash	% DM	7.5	2.3	5.0	10.5	6
Gross energy	MJ/kg DM	19.2				*

Minerals	Unit	Avg	SD	me	Max	Nb
Calcium	g/kg DM	3.6		1.2	6.0	2
Phosphorus	g/kg DM	3.2		2.8	3.6	2
Potassium	g/kg DM	12.4				1
Magnesium	g/kg DM	3.2				1
Manganese	mg/kg DM	75		17	133	2
Zinc	mg/kg DM	32		11	52	2
Copper	mg/kg DM	38				1
Iron	mg/kg DM	890				1

Secondary metabolites	Unit	Avg	SD	me	Max	Nb
Tannins (eq. tannic acid)	g/kg DM	7.5		5.0	10.0	2

Ruminant nutritive values	Unit	Avg	SD	me	Max	Nb
OM digestibility, ruminants	%	26.4				1
Nitrogen digestibility, ruminants	%	11.9				1

The asterisk * indicates that the average value was obtained by an equation.

References

Dewar, 1967; Kellner et al., 1902; Patel, 1966; Singhal et al., 1986

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Mahua (Madhuca longifolia), seed cake, solvent-extracted

Main analysis	Unit	Avg	SD	me	Max	Nb
Crude protein	% DM	21.2	4.8	15.9	29.4	6
Crude fibre	% DM	8.6	1.2	7.0	9.9	5
Ether extract	% DM	1.4	1.4	0.1	4.1	6
Ash	% DM	6.8	1.2	5.9	8.9	6
Gross energy	MJ/kg DM	18.0				*

Minerals	Unit	Avg	SD	me	Max	Nb
Calcium	g/kg DM	2.8	1.6	1.6	4.6	3
Phosphorus	g/kg DM	4.1	3.7	0.9	8.1	3
Sodium	g/kg DM	0.3				1
Magnesium	g/kg DM	3.6		3.5	3.6	2
Manganese	mg/kg DM	66	78	19	156	3
Zinc	mg/kg DM	92	94	26	200	3
Copper	mg/kg DM	23	12	10	34	3
Iron	mg/kg DM	224				1

Amino acids	Unit	Avg	SD	me	Max	Nb
Alanine	% protein	6.4		5.6	7.2	2
Arginine	% protein	6.9		6.0	7.8	2
Aspartic acid	% protein	8.4	1.8	6.5	10.0	3
Cystine	% protein	2.0		1.9	2.0	2
Glutamic acid	% protein	19.1		17.8	20.4	2
wistaria	% protein	5.2		4.2	6.2	2
Histidine	% protein	2.3	0.3	2.1	2.6	3
Isoleucine	% protein	2.9		2.8	3.0	2
Leucine	% protein	8.2	1.5	7.1	9.9	3
Lysine	% protein	4.5	0.7	3.7	5.1	3
Methionine	% protein	1.4		1.1	1.6	2
Phenylalanine	% protein	4.6	1.7	3.2	6.5	3
Proline	% protein	6.7		4.9	8.5	2
Serine	% protein	4.8		4.0	5.6	2
Threonine	% protein	4.4	0.7	3.7	5.1	3
Tryptophan	% protein	1.0		0.9	1.0	2
Tyrosine	% protein	3.3		2.1	4.5	2
Valine	% protein	5.6		5.2	5.9	2

Secondary metabolites	Unit	Avg	SD	me	Max	Nb
Tannins (eq. tannic acid)	g/kg DM	21.0		10.0	31.9	2
Tannins, condensed (eq. catechin)	g/kg DM	12.1				1

The asterisk * indicates that the average value was obtained by an equation.

References

Ajay Singh et al., 1991; Barman et al., 2006; Krishna, 1985; Morgan et al., 1980; Singhal et al., 1986

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Mahua (Madhuca longifolia), leaves, fresh

Main analysis	Unit	Avg	SD	me	Max	Nb
Crude protein	% DM	9.1		9.1	9.1	2
Crude fibre	% DM	18.9		18.7	19.0	2
Ether extract	% DM	4.0		3.9	4.1	2
Ash	% DM	7.7		7.6	7.8	2
Gross energy	MJ/kg DM	18.1				*

Minerals	Unit	Avg	SD	me	Max	Nb
Calcium	g/kg DM	15.0		14.6	15.3	2
Phosphorus	g/kg DM	2.2		2.1	2.2	2

Ruminant nutritive values	Unit	Avg	SD	me	Max	Nb
OM digestibility, ruminants	%	63.6				1
Nitrogen digestibility, ruminants	%	71.0				1

The asterisk * indicates that the average value was obtained by an equation.

References

Patel, 1966; Sen, 1938

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Heuzé V. , Tran G. , H. Archimedes , Bastianelli D. , Lebas F. , 2016. *Mahua (Madhuca longifolia)* . Feedipedia, a program by INRA, CIRAD, AFZ and FAO. http://www.feedipedia.org/node/131 *Last updated on September 16, 2016, 1:20*

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Mahua (Madhuca longifolia)

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