

Velvet bean (*Mucuna pruriens*)

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

Velvet bean, Mauritius velvet bean, Bengal bean, Florida velvet bean, Yokohama velvet bean, cowage, cowhage, cowitch, lacuna bean, Lyon bean, itchy bean, krame, buffalobean, pica-pica, kapikachhu [English]; pois mascate, dolic, haricot de Floride, haricot de Maurice, pois velus, haricot pourpre, pois du Bengale [French]; grano de terciopelo, frijol terciopelo, picapica, chiporro, nescafe, mucuna, fogaraté, café incasa, café listo, frijol abono [Spanish]; feijão-da-florida, po de mico, fava coceira [Portuguese]; fluweelboon [Dutch]; Juckbohne [German]; pwa grate [Haitian creole]; Kara benguk [Indonesian]; đậu mèo rùng, móc mèo [Vietnamese]; [Bengali]; [Burmese]; 刺毛豇豆 [Chinese]; [Hindi]; ハッシュヨウマメ [Japanese]; [Malayalam]; [Nepali]; مگونا پرورینز [Persian]; [Punjabi]; Мукуна жгучая [Russian]; [Telugu]; ทมขี้มู [Thai]

Species

Mucuna pruriens (L.) DC. var. *utilis* (Wall. ex Wight) Baker ex Burck [Fabaceae]

Synonyms

Carpopogon capitatum Roxb., *Carpopogon capitatus* Roxb., *Carpopogon niveum* Roxb., *Macranthus cochinchinensis* Lour., *Mucuna aterrima* (Piper & Tracy) Holland, *Mucuna atrocarpa* F.P. Metcalf, *Mucuna capitata* Wight & Arn., *Mucuna deeringiana* (Bort) Merr., *Mucuna hassjoo* (Piper & Tracy) Mansf., *Mucuna martinii* H. Lev. & Vaniot, *Mucuna nivea* (Roxb.) Wight & Arn., *Mucuna pruriens* (L.) DC. var. *capitata* Burck, *Mucuna pruriens* (L.) DC. var. *capitata* (Wight & Arn.) Burck, *Mucuna pruriens* (L.) DC. var. *nivea* (Roxb.) Haines, *Mucuna utilis* Wight, *Stizolobium aterrimum* Piper & Tracy, *Stizolobium deeringianum* Bort, *Stizolobium hassjoo* Piper & Tracy, *Stizolobium pruriens* (L.) Medik., *Stizolobium pruriens* (L.) Medik. var. *hassjoo* (Piper & Tracy) Makino, *Stizolobium utile* (Wall. ex Wight) Ditmer, *Stizolobium niveum* (Roxb.) Kuntze

Feed categories

- Legume forages
- Legume seeds and by-products
- Forage plants

Related feed(s)

Description

Velvet bean (*Mucuna pruriens* (L.) DC. var. *utilis* (Wall. ex Wight) Baker ex Burck) is a leguminous vine. It is annual or sometimes short-lived perennial. Velvet bean is vigorous, trailing or climbing, up to 6-18 m long (US Forest Service, 2011; Wulijarni-Soetjipto et al., 1997). It has a taproot with numerous, 7-10 m long, lateral roots. The stems are slender and slightly pubescent (Wulijarni-Soetjipto et al., 1997). The leaves are generally slightly pubescent, alternate, trifoliolate with rhomboid ovate, 5-15 cm long x 3-12 cm broad, leaflets (US Forest Service, 2011; Wulijarni-Soetjipto et al., 1997). The inflorescence is a drooping axillary raceme that bears many white to dark purple flowers. After flower pollination, velvet bean produces clusters of 10 to 14 pods. They are stout, curved, 10-12.5 cm long, with between two and six seeds, covered with greyish-white or orange hairs that may cause irritation to the skin (US Forest Service, 2011). The velvet bean seeds are variable in colour, ranging from glossy black to white or brownish with black mottling. Seeds are oblong ellipsoid, 1.2 to 1.5 cm long, 1 cm broad and 0.5 cm thick (FAO, 2011; US Forest Service, 2011; Wulijarni-Soetjipto et al., 1997).

Velvet beans have three main uses: food, feed (forage and seeds) and environmental services. The young leaves, pods and seeds are edible and used in several food specialties including "tempeh", a fermented paste made of boiled seeds, originally from Indonesia. In Central America velvet bean is also used as a coffee substitute (Eilittä et al., 2003). The plant can be a cover crop, and provides fodder and green manure. In the USA, velvet bean is also used as an ornamental species (Wulijarni-Soetjipto et al., 1997). There are numerous cultivars of velvet bean in the world (FAO, 2011).

Velvet bean is a valuable fodder and feed legume. Vines and foliage can be used as pasture, hay or silage for ruminants while pods and seeds can be ground into a meal and fed to both ruminants and monogastrics (Chikagwa-Malunga et al., 2009d; Eilittä et al., 2003). Pods with their seeds can be ground into a rich protein meal and can be fed to all classes of livestock though in limited amounts in monogastrics (Chikagwa-Malunga et al., 2009d).

Distribution

Velvet bean originated from southern Asia and Malaysia and is now widely distributed in the tropics (FAO, 2011). It was introduced to the southern states of the USA in the late 19th century and from there was reintroduced to the tropics in the early part of the 20th century (Eilittä et al., 2003). Velvet bean is found from sea level up to an altitude of 2100 m (Ecocrop, 2011). It requires a hot moist climate with annual rainfall ranging from 650 to 2500 mm and a long frost-free growing season during the wet months. It can grow on a wide range of soils, from sands to clays but thrives on well-drained, light textured soils of appreciable acidity (FAO, 2011; Pengelly et al., 2004).

Automatic translation

Sélectionner une langue

Feed categories

All feeds

Forage 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

Processes

Many treatments have been proposed to decrease the content in antinutritional factors of the seeds, such as boiling in water for one hour, autoclaving for 20 minutes, water-soaking for 48 h and then boiling for 30 minutes, or soaking the cracked seeds for 24 h in 4% Ca(OH)₂ (Cook et al., 2005; Pugalenthi et al., 2005).

Forage management

Yields

Velvet bean is suitable in intercropping systems where it is grown with maize (Cook et al., 2005), pearl millet, sorghum or sugarcane for support (Göhl, 1982). The crop gives reliable yields in dry farming and low soil fertility conditions that do not allow the profitable cultivation of most other food legumes (Buckles et al., 1998). Velvet bean yields range from 10 to 35 t green material/ha and from 250 to 3300 kg seeds/ha depending on the cultivation conditions (Ecocrop, 2011).

Harvesting of velvet bean pods can start as soon as they start turning from green to dark brown or black; in Malaysia this is possible 215 to 255 days after sowing. Pods are harvested by hand (Wulijarni-Soetjipto et al., 1997).

Grazed pasture

Animals can enter the sward after the pods have matured. In Hawaii, grazing 170 to 220 days after sowing resulted in yields of 19 t/ha of green forage and 3.85 t/ha of seeds (Takahashi et al., 1949 cited by FAO, 2011).

Cut forage

When velvet bean is intended for forage, it may be harvested when the pods are still young, usually between 90-120 days after sowing (Wulijarni-Soetjipto et al., 1997; Ravindran, 1988). Harvesting at about 120 days after planting resulted in the best combination of biomass yield and nutritive value (Chikagwa-Malunga et al., 2009a). In Malaysia, the first harvest for fodder can be done 2 months after sowing. A cutting interval of 5 weeks and cutting at a height of 30 cm provides a reasonable yield of forage of adequate quality (Wulijarni-Soetjipto et al., 1997). Yields of green fodder may be up to 20-35 t/ha resulting in 8.2-16.4 t DM/ha (Ecocrop, 2011).

Hay

Because of its dense matted growth, velvet bean is difficult to harvest and cure for hay (FAO, 2011). Yields of hay average 2.8-3.6 t/ha (Ecocrop, 2011).

Silage

Velvet beans may be cultivated for silage, but they are hard to harvest and flail-type harvesters do a better job than using combine machines. Velvet bean can be grown in mixture and ensiled in combination with a grain crop, maize being the usual choice but sorghum is also a possibility, or with grasses such as Napier grass (Contreras-Govea et al., 2009; Mbuthia et al., 2003). However, because velvet beans are difficult to harvest, it is also recommended to grow them and the companion crop separately and then mixing when ensiling (FAO, 2011).

Environmental impact

Cover crop and soil improver

The main attributes of velvet bean are its fast growth and its long growing season in frost-free environments. It is thus possible for velvet bean to protect the soil through the wet monsoon season (FAO, 2011; Cook et al., 2005).

Velvet bean is an N-fixing legume that has no specific rhizobium requirements, but N fixation is favoured by warm temperatures (FAO, 2011).

As a leguminous species velvet bean is reported to improve soil fertility: it provides more than 10 t DM aboveground biomass/ha, and below ground it fixes some 331 kg N/ha, equivalent to 1615 kg ammonium sulfate/ha (Cook et al., 2005; Buckles et al., 1998; Wulijarni-Soetjipto et al., 1997). Velvet bean also yields 100 kg K/ha, and 20 kg P/ha (Buckles et al., 1998). It is widely grown in Central America, either relay planted with maize or as a rainy season fallow crop in rotation with dry season maize. It was reported to improve maize yield by between 500 kg and 2 t/ha after a one-year fallow (ILRI, 2004; Wulijarni-Soetjipto et al., 1997).

Velvet bean is mainly grown as a cover crop and green manure because it can establish very quickly without requiring complete soil preparation (Cook et al., 2005). In intercropping systems including maize and velvet bean, the fast growing legume accumulates nutrient through N fixation and it protects the soil from heavy rains in the wet season. Once slashed into a thick mulch, the velvet bean foliage protects the soil from erosion and prevents weed germination. Velvet bean also has a positive effect on soil moisture (Buckles et al., 1998).

As a cover crop, velvet bean sown in rubber plantations can yield about 2 t/ha of fresh organic matter within 6 months (Wulijarni-Soetjipto et al., 1997). In Sri Lanka, it has been planted as a cover crop in coconut plantations (Ravindran, 1988). It used to be an important cover crop in citrus and banana plantations (Wulijarni-Soetjipto et al., 1997).

Weed and pest control

Velvet bean has an overall beneficial effect on companion crops in intercropping systems due to its pest and disease resistance. When established, the crop smothers weeds effectively (FAO, 2011). Velvet bean is one of the most suitable crops for reclaiming land infested with weeds, notably *Cynodon dactylon*, *Cyperus* species, *Saccharum spontaneum* and *Imperata cylindrica* (Hellin, 2006; Wulijarni-Soetjipto et al., 1997). In Brazil, it is recommended for use in rotation with cotton to limit *Fusarium oxysporum* infestation. It can also effectively control nematode infestation by species such as *Meloidogyne incognita* (Wolf et al., 2003; Wulijarni-Soetjipto et al., 1997).

Datasheet citation

Heuzé V., Tran G., Hassoun P., Renaudeau D., Bastianelli D., 2015. Velvet bean (*Mucuna pruriens*). Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/270> Last updated on October 13, 2015, 13:42

English correction by Tim Smith (Animal Science consultant) and Hélène Thiollot (AFZ)

Image credits

● Scott Zona ● Scott Zona ● Ton Rulkens ● Ton Rulkens ● Scamperdale



Velvet bean (*Mucuna pruriens*)

Description

Nutritional aspects

Nutritional tables

References

Nutritional attributes

Velvet bean forage contains 15-20% protein (DM basis) (Sidibé-Anago et al., 2009). Seeds are rich in protein (24-30%), starch (28%) and gross energy (10-11 MJ/kg) (Pugalenthi et al., 2005; Siddhuraju et al., 2000). They also contain desirable amino acids, fatty acids and have a good mineral composition (Vadivel et al., 2007). The main problems with velvet bean seeds, notably in monogastric animals, are the various antinutritional factors they contain (see **Potential constraints** below).

Potential constraints

Most toxicological problems with velvet bean are due to its seeds.

L-dopa

Velvet bean seeds and, to a smaller extent stems and leaves, contain two important non-protein amino-acids: L-dopa from which dopamine, a potent anti-Parkinson disease agent, is prepared, and DMP (dimethyltryptamine), an hallucinogenic substance. L-dopa content varies from 1.6 to 7% (Cook et al., 2005; Wulijarni-Soetjipto et al., 1997). Ensiling decreased L-dopa content in the seeds by 10-47% (Matenga et al., 2003).

L-dopa is a potent antinutritional factor (Siddhuraju et al., 2002) and may cause severe vomiting and diarrhoea in pigs fed large quantities of velvet bean seeds. It is less harmful in ruminants: it does not appear to modify rumen fermentation and there is a rumen microbial adaptation to L-Dopa (Chikagwa-Malunga et al., 2009b). Trials in sheep and goats fed velvet beans and pods did not find that L-dopa had any adverse effects (Matenga et al., 2003; Castillo-Camaal et al., 2003a; Pérez-Hernandez et al., 2003; Castillo-Camaal et al., 2003b; Mendoza-Castillo et al., 2003).

Alkaloids

Velvet bean seeds contain a number of alkaloids, notably mucunain, pruriene and serotonin. Mucunain is produced by pod hairs. It causes severe itching to the skin, and the hairs coming in contact with the eyes can be very painful. L-dopa may also be implicated in skin eruptions (Pugalenthi et al., 2005). The negative effects of mucunain are potentialized by serotonin (Cook et al., 2005). It has been reported that haemorrhage and death can result from cattle eating the hairy pods (Miller, 2000). Pod hairs have the same anthelmintic efficacy as piperazine against ascariasis in buffalo calves (Behura et al., 2006).

Other antinutritional factors

Velvet bean seeds contain other antinutritional factors:

- Trypsin and chymotrypsin-inhibiting activities decrease protein digestibility, induce pancreatic hypertrophy and hyperplasia, increase trypsin secretion and, therefore, reduce N retention, growth and feed conversion (Pugalenthi et al., 2005; van Eys et al., 2004; Rackis et al., 1986).
- Phytate content is relatively high in the seeds and may reduce mineral and protein availability (Pugalenthi et al., 2005).
- Oligosaccharides (mainly verbascose) cause flatulence (Pugalenthi et al., 2005).
- HCN is found in velvet bean seeds, but in amounts well below (5.8 mg/100g) the lethal dose (35 mg/100g) (Pugalenthi et al., 2005).
- Lectins and saponins are also found (Pugalenthi et al., 2005).

These antinutritional factors can be efficiently reduced by a wide range of treatments (see **Processes** on the "Description" tab).

Ruminants

Both meat and milk production can benefit from including legumes such as velvet bean forage and pods in feeds (Pengelly et al., 2004).

Pasture is the most important use of velvet bean. It is never fully grazed by stock until it is well matured or frosted. It makes rather poor hay, especially if cut when mature, as the leaves are easily shed; also, the long vines are difficult to handle. Good silage can be made from velvet bean together with its supporting crop. It usually turns black after a time, but without impairing its quality (Göhl, 1982). Maize cultivated with velvet bean can be ensiled without any adverse effect on silage quality (Contreras-Govea et al., 2009). In Honduras, farmers developed over several years a valuable maize cropping system combined with velvet beans (Buckles et al., 1999).

Ruminants can also be fed pods and seeds. It is more economical to grind the whole pods rather than to separate the pods and the seeds (Göhl, 1982).

Growing and fattening cattle

Velvet bean forage was found to be an interesting feed for ruminants even in areas with low-fertility soils and a short rainy season. Zebu cows and heifers fed low quality hay ingested 61.8 to 76 g/kg W^{0.75} of velvet bean hay (Sidibé-Anago et al., 2009). In Zimbabwe, it proved to be a cost-effective forage legume for growing cattle on natural rangeland (veld): the animals gained weight when supplemented with velvet bean hay at 1.5% BW or more (+ 20 kg in 3 months at 2% BW), and lost weight when not supplemented or supplemented at 1% BW (-40 kg and -20 kg respectively). In pen-fattened animals, velvet bean hay replaced the commercial concentrate, and a diet of maize grain and velvet bean hay (5:3 ratio) plus *ad libitum* access to maize stover gave similar weight gain as the control diet (Murungweni et al., 2004).

Dairy cattle

Automatic translation

Feed categories

All feeds

Forage 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

In dairy cows, several trials in East and Southern Africa have shown that supplementation of grass-based diets with velvet bean forage, fresh or hay, can increase production (compared to non-supplemented diets) or maintain it (compared to other protein supplements). These trials are summarised in the table below:

Country	Animals	Diet	Performance	References
Kenya	Jersey cows	Chopped velvet bean (1.4 kg DM/d) + Napier grass + maize bran	Milk 6.3 kg/d (12 weeks)	Mureithi et al., 2003
Kenya	Jersey cows	Chopped velvet bean (2 kg DM/d) + Napier grass + maize bran	Milk 5.5 kg/d (24 weeks)	Muinga et al., 2003
Kenya	Jersey cows	Chopped velvet bean (1.6 kg DM/d) + Napier grass + maize bran	Milk 5.3 kg/d	Juma et al., 2006
Kenya	Holstein-Friesian cows	Velvet bean hay (2.1 kg DM/day) + Napier grass	Milk 3.75 kg/d	Nyambati et al., 2003
Zimbabwe	Jersey cows	Velvet bean hay + crushed maize grain in 5:4 ratio	Milk 9.0 kg/d	Murungweni et al., 2004

When compared to other legumes (*Gliricidia sepium*, *Lablab purpureus* and *Clitoria ternatea*), fresh velvet bean forage resulted in lower (Mureithi et al., 2003) or identical milk yield (Juma et al., 2006), but another comparison with *Gliricidia* in similar conditions resulted in higher milk yield for velvet bean forage (Muinga et al., 2003). A velvet bean hay-based diet gave higher milk yield than a lablab hay-based diet, but Jersey cows eating either diet produced good quality milk that met the expected minimum market standards (Murungweni et al., 2004).

When cultivated in association with maize, velvet bean forage increased the protein content of the mixture, but did not increase the milk yield of dairy cattle (Armstrong et al., 2008).

Draught cattle

Velvet bean hay can significantly benefit smallholder farmers who rely on cattle as draught power. It is necessary for such farmers to supplement their animals during the dry winter season if they are to retain the draught capacity of the animals for the following season (Murungweni et al., 2004).

Sheep and goats

In young rams, velvet bean hay caused metabolic disorders (diarrhoea) if given in excess of 2.6% of the body weight. Feeding velvet bean hay offered in the morning at 2.5% body weight, and poor-quality roughage such as wheat bran or maize stover offered in the afternoon was found to be a workable diet (Murungweni et al., 2004).

Other trials have focused on the supplementation of forage diets with velvet bean seeds and pods. Velvet beans were able to support growth and milk production, and improved performance when compared to grazing or grass-only diets. They also compared favourably with other supplements, though they gave poorer results in some trials. However, no adverse effects were recorded (Castillo-Camaal et al., 2003a; Pérez-Hernandez et al., 2003; Castillo-Camaal et al., 2003b; Chikagwa-Malunga et al., 2009c; Mendoza-Castillo et al., 2003; Matenga et al., 2003).

The addition of a small quantity of molasses may improve consumption (Matenga et al., 2003) and reduce dustiness (Pérez-Hernandez et al., 2003).

Ensiling decreased L-dopa content and increased energy intake and N retention, but lowered the crude protein, so that milk production was not increased (Matenga et al., 2003). Results from feeding velvet bean pods to sheep are summarized in the table below:

Country	Animals	Diet	Performance	References
Mexico	Pelibuey growing males	5-10 g/kg BW pods + Napier grass	ADG 60 g/d (44 with control diet)	Castillo-Camaal et al., 2003a
Mexico	Male growing lambs	Ground pods (20%) + concentrate (20%) + Napier grass (60%) + 200 g molasses	DMI 780 g/d DMD 68%	Pérez-Hernandez et al., 2003
Mexico	Male growing lambs	Ground pods (40%) + Napier grass (60%) + 200 g molasses	DMI 650 g/d DMD 64%	Pérez-Hernandez et al., 2003
Mexico	Male growing lambs	<i>Ad libitum</i> ground pods (5 kg to 4 animals / day), with 300 g molasses	DMI 680 g/d	Pérez-Hernandez et al., 2003
Mexico, farm trial	Growing lambs	400 g/d ground pods + grazing secondary vegetation	ADG 95 g/d (63 g/d when only grazing)	Castillo-Camaal et al., 2003b
USA (Florida)	Rambouillet wether lambs	Rolled velvet bean seeds (0-24% replacing 0-100% of soybean meal) + concentrate + Bermuda grass	DMI 1.4-1.6 kg/d DMD 77-80% No difference between treatments	Chikagwa-Malunga et al., 2009c
USA (Florida)	Rambouillet wether lambs	Rolled velvet bean seeds (0-23% replacing 0-100% of soybean meal) + concentrate + Bermuda grass	ADG 130-140 g/d (200 g/d for control diet) Good rumen conditions No differences on carcass composition	Chikagwa-Malunga et al., 2009c

Results from feeding velvet bean pods to goats are summarized in the table below:

Country	Animals	Diet	Performance	References
Mexico	Lactating Creole goats	870 g/d ground seeds + Napier grass	Milk 600 g/d Total DMI and milk yield positively correlated to velvet bean intake Slight trend of weight loss	Mendoza-Castillo et al., 2003
Mexico, farm trial	Lactating goats	500 g/d ground pods + grazing secondary vegetation	Weight loss -0.85 kg in 70 d (-1.4 kg when grazing only)	Castillo-Camaal et al., 2003b
Mexico, farm trial	Growing kids, pre-suckling	400 g/d ground pods + grazing secondary vegetation	ADG 130-214 g/d (86-110 when grazing only)	Castillo-Camaal et al., 2003b
Mexico, farm trial	Growing kids, post-suckling	400 g/d ground pods + grazing secondary vegetation	ADG 100 g/d with or without pods	Castillo-Camaal et al., 2003b
Zimbabwe	Lactating Mashona goats	Ground seeds + ground maize (50:50), ensiled (1.2 kg/d DM) or not (1.1 kg/d DM)	Milk 0.61-0.62 L/d DMI 718 g/d (fresh); DMI 935 g/d (ensiled) Ensiling increased intake but not milk yield or kid weight gain	Matenga et al., 2003

Pigs

The relatively high protein and energy value of velvet bean seeds make them a suitable feed for pigs (Pugalenthi et al., 2005). In some cases, pigs are allowed to graze velvet bean pastures to consume the beans that have been left behind after harvesting (Göhl, 1982).

However, the use of velvet bean seeds is limited by their deficiency in sulphur-containing amino acids (Pugalenthi et al., 2005), and by the presence of numerous antinutritional and toxic factors (see **Potential Constraints** above). Feeding raw seeds can result in deleterious effects on pig performance as well as their blood constituents (Sridhar et al., 2007). Pigs should not be allowed to consume large amounts of velvet bean, either as forage or seeds (Göhl, 1982). Various maximum inclusion rates have been reported: some authors claimed that velvet beans can be included at up to 25% of the diet, while others found that such a high rate may cause severe vomiting and diarrhoea, and proposed 5% as a much safer level. The incorporation of 15% of raw velvet beans in pig feeding caused 50% mortality in young animals (Emenalom et al., 2004).

In all circumstances processing of velvet bean seeds is necessary in order to be able to use them safely in pig feeds. Boiled seeds included at 25% could satisfactorily replace maize in a diet for 40 kg pigs (Lizama et al., 2003). A more extensive process, consisting of cracking the seeds, soaking them in water for 48 h and boiling them for 1 hour allowed the use of up to 40% seeds in the diets of 15-35 kg pigs. This treatment also allowed full replacement of the soybean meal while maintaining growth rate (341-351 g/d) and feed conversion ratio (2.53-2.58) (Emenalom et al., 2004).

Poultry

While proximate composition of velvet bean seeds makes it tempting to use them in poultry diets, the presence of antinutritional factors limits their practical interest, unless appropriate technological treatments are found (Carew et al., 2006).

Broilers, quails and Guinea fowls

Raw velvet bean seeds should be avoided in broiler diets. Processed seeds (dry roasting or soaking + boiling) can be included at up to 10% of the diet with an adapted feed formulation, but even processed seeds should be used carefully and probably avoided for starter animals.

Performance is markedly reduced in broilers fed raw velvet beans (Harms et al., 1961; Ferreira et al., 2003; Emiola et al., 2007; Emenalom et al., 2005b; Tuleun et al., 2008a). This reduction can occur at low levels of incorporation: 5% raw velvet beans can induce a 25% drop in animal performances (Iyayi et al., 2006b). Significant mortality rates can be registered at high levels of inclusion (Harms et al., 1961; Del Carmen et al., 1999). The effects were similar in Guinea fowl (Dahouda et al., 2009a). Velvet beans appear to be more detrimental to growth than to feed intake, although results differ among authors (Trejo et al., 2004; Emiola et al., 2007; Tuleun et al., 2008a, etc.). The feed conversion ratio is always markedly reduced.

Treatments, and particularly heat treatments, can help to reduce the negative effects of velvet beans (Carew et al., 2006). However, performance is seldom completely restored compared to control diets even if differences can be statistically non-significant at lower inclusion rates. The main treatments that have been tested include: soaking (with or without additives in water), boiling, autoclaving, dry roasting and combinations of these techniques. These treatments help to decrease the levels of antinutritional factors such as antitryptic factors, L-dopa, tannins and hemagglutination factors (Vadivel et al., 2011).

Dry roasting has been found to be an efficient way to limit the negative effects of velvet beans in broilers and Japanese quails (Del Carmen et al., 1999; Emiola et al., 2007; Ukachukwu et al., 2007b; Tuleun et al., 2009a). However other authors compared various treatments and found roasting less efficient than boiling in broilers and in Guinea fowls (Emenalom et al., 2005b; Dahouda et al., 2009a).

Regarding wet treatments, soaking alone (in water with or without additives) is not efficient (Nyirenda et al., 2003; Tuleun et al., 2010b; Vadivel et al., 2011), therefore, it should be combined to a heat treatment such as boiling or autoclaving. The duration of thermal treatments can have an effect on their efficiency: boiling velvet bean seeds for 20 minutes resulted in lower growth rates than boiling for 40 or 60 min (Tuleun et al., 2008a). For several authors, the optimal treatment consisted of soaking in water or sodium bicarbonate, followed by boiling (60 to 90 min) and drying. This procedure was found to eliminate antinutritional factors efficiently (Vadivel et al., 2011) and broiler performance was maintained at up to 10-20% inclusion of velvet beans in the diet (Ukachukwu et al., 2003; Akinmutimi et al., 2006; Emenalom et al., 2006; Ukachukwu et al., 2007a; Ani, 2008; for Guinea fowls: Farougou et al., 2006). However, even roasted and soaked + boiled seeds can reduce performance at low inclusion rates (6-10%) (Emenalom et al., 2005a; Iyayi et al., 2003; Vadivel et al., 2011).

Thermal treatment also improved protein digestibility, probably by inactivation of the antinutritional factors: for example 1 h dry exposure at 100°C increased protein digestibility from 65% to 74% (Iyayi et al., 2008).

The metabolizable energy value of velvet bean seeds varies with the process, as shown in the table below:

Process	Energy type	Energy value	References
Raw seed	TME	4.4 MJ/kg	Ukachukwu et al., 1999
Toasted	TME	12.6 MJ/kg	Ukachukwu et al., 1999
Boiled	TME	13.5 MJ/kg	Ukachukwu et al., 1999
Soaked and boiled	TME	13.4 MJ/kg	Ukachukwu et al., 1999
Boiled	AME	13.1 MJ/kg	Emiola et al., 2007
Toasted	AME	13.0 MJ/kg	Emiola et al., 2007

Laying hens and quails

Using velvet bean seeds, even when processed, is not recommended in commercial egg production though economic considerations may make them profitable.

The use of raw velvet bean seeds in layer diets can result in a marked reduction in performance. Daily egg production dropped from 78.5% to 65.5% with 12.5% raw seeds in the diet (Harms et al., 1961), and from 84% to 38% with 20% inclusion (Tuleun et al., 2008b).

Treatment reduce the negative effects of velvet bean seeds, but did not enable the same performance as control diets with lower levels of velvet bean seeds: in laying hens, the best treatment (toasting) allowed 74% hen-day egg production vs. 84% from the control diet with 20% velvet bean seeds, while boiled seeds yielded 59% hen-day egg production (Tuleun et al., 2008b). In laying Japanese quails, 15% toasted seeds caused a significant reduction in performance, but the lower feed cost per egg produced, and feed cost per bird, justified using velvet bean seeds (Tuleun et al., 2010b). Egg composition and quality were not affected by the inclusion of velvet bean seeds (Iyayi et al., 2003; Tuleun et al., 2008b).

Rabbits

Velvet bean seed meal and velvet bean leaves can be fed to rabbits. Seeds and leaves can be fed together to rabbits, resulting in higher intake, increased diet digestibility and higher growth rates (208 g/week vs. 67 g/week on a basal diet) ([Aboh et al., 2002](#)). Up to 20% cooked velvet bean seed meal can be included in the diet of weaned rabbits ([Taiwo et al., 2006](#)). Velvet bean leaves compared favourably with soybean meal and gave similar daily weight gains (15 g/day vs. 16 g/day) ([Bien-Aimé et al., 1989](#)).

Fish

Velvet bean seeds, like other tropical legume seeds, are a potential feed ingredient for fish diets, due to their high protein and carbohydrate content, which make them a potential substitute for fish meal and cereals ([Ogunji et al., 2003](#)). However, their use is limited by the presence of antinutritional factors and by an amino acid profile that does not meet the requirements of fish ([Ogunji et al., 2003](#)). Heat treatments as well as supplementation with other protein sources are therefore required ([Hertrampf et al., 2000](#); [Ogunji et al., 2003](#)).

Velvet beans have been tested in the following fish species:

African catfish (*Clarias gariepinus*)

Low inclusion rates (5%) of raw velvet bean seeds were recommended in juveniles of African catfish (*Clarias gariepinus*) ([Aderolu et al., 2009](#)).

Nile tilapia (*Oreochromis niloticus*)

In tilapia diets, it was possible to replace up to 25% of the dietary protein with soaked and autoclaved velvet bean seeds ([Siddhuraju et al., 2003](#)).

Common carp (*Cyprinus carpio*)

For common carp (*Cyprinus carpio*), the level of L-Dopa should not be higher than 7 g/kg in the diet. The level of raw or processed velvet bean seeds should not exceed 20% as it has deleterious effects on growth rate and feed utilisation ([Siddhuraju et al., 2001](#); [Siddhuraju et al., 2002](#)).

Datasheet citation

Heuzé V., Tran G., Hassoun P., Renaudeau D., Bastianelli D., 2015. Velvet bean (*Mucuna pruriens*). Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/270> Last updated on October 13, 2015, 13:42

English correction by Tim Smith (Animal Science consultant) and Hélène Thiollet (AFZ)

Image credits

● Scott Zona ● Scott Zona ● Ton Rulkens ● Ton Rulkens ● Scamperdale

[+](#) Share / Save [f](#) [t](#) [r](#)



Velvet bean (*Mucuna pruriens*)

[Description](#) [Nutritional aspects](#) [Nutritional tables](#) [References](#)

Tables of chemical composition and nutritional value

- Velvet bean (*Mucuna pruriens*), aerial part, fresh
- Velvet bean (*Mucuna pruriens*), hay
- Velvet bean (*Mucuna pruriens*), pod husks
- Velvet bean (*Mucuna pruriens*), pods
- Velvet bean (*Mucuna pruriens*), seeds

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

Velvet bean (*Mucuna pruriens*), aerial part, fresh



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	24.7	7.8	15.0	45.4	17
Crude protein	% DM	16.0	4.1	10.2	25.9	23
Crude fibre	% DM	27.1	5.9	14.2	36.6	18
NDF	% DM	38.5	25.4	10.3	59.6	3
ADF	% DM	34.2	15.6	7.1	45.6	5
Lignin	% DM	12.5	2.4	10.0	14.9	3
Ether extract	% DM	2.4	0.9	1.3	4.7	18
Ash	% DM	7.9	1.8	5.2	12.2	23
Gross energy	MJ/kg DM	18.6				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	10.3	2.4	6.3	14.2	20
Phosphorus	g/kg DM	1.9	0.5	1.2	3.1	17
Potassium	g/kg DM	15.6	5.8	6.7	24.9	19
Sodium	g/kg DM	0.1	0.0	0.0	0.1	6
Magnesium	g/kg DM	2.8	0.9	0.6	4.5	19
Manganese	mg/kg DM	70		14	126	2
Zinc	mg/kg DM	71	75	23	157	3
Copper	mg/kg DM	20	6	16	27	3
Iron	mg/kg DM	740		335	1145	2

Secondary metabolites	Unit	Avg	SD	Min	Max	Nb
Tannins (eq. tannic acid)	g/kg DM	18.0				1

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, Ruminant	%	68.1		68.0	69.8	2 *
Energy digestibility, ruminants	%	65.1				*
DE ruminants	MJ/kg DM	12.1				*
ME ruminants	MJ/kg DM	9.7				*
Nitrogen digestibility, ruminants	%	74.0		73.0	75.0	2

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

References

Adjolohoun, 2008; Axtmayer et al., 1938; Barnes, 1999; CIRAD, 1991; Devendra et al., 1970; Diaz et al., 2002; Gowda et al., 2004; Juma et al., 2006; Ly et al., 2002; Pozy et al., 1996; Xandé et al., 1989

Last updated on 24/10/2012 00:45:16

Velvet bean (*Mucuna pruriens*), hay



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	90.6				1

Automatic translation

Sélectionner une langue

Feed categories

All feeds

Forage 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

Crude protein	% DM	14.8	1
Crude fibre	% DM	30.7	1
Ether extract	% DM	2.6	1
Ash	% DM	8.9	1
Gross energy	MJ/kg DM	18.5	*

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, Ruminant	%	60.8				*
Energy digestibility, ruminants	%	57.3				*
DE ruminants	MJ/kg DM	10.6				*
ME ruminants	MJ/kg DM	8.5				*
Nitrogen digestibility, ruminants	%	63.9				1

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

References

Walker, 1975

Last updated on 24/10/2012 00:45:16

Velvet bean (*Mucuna pruriens*), pod husks



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	89.2				1
Crude protein	% DM	4.3				1
Crude fibre	% DM	42.4				1
Ether extract	% DM	0.7				1
Ash	% DM	5.9				1
Gross energy	MJ/kg DM	18.3				*

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, Ruminant	%	80.7				*

Pig nutritive values	Unit	Avg	SD	Min	Max	Nb
Energy digestibility, growing pig	%	23.5				*
DE growing pig	MJ/kg DM	4.3				*

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

References

Naik, 1967

Last updated on 24/10/2012 00:45:17

Velvet bean (*Mucuna pruriens*), pods



Main analysis	Unit	Avg	SD	Min	Max	Nb
Crude protein	% DM	21.0				1
Crude fibre	% DM	15.6				1
Ether extract	% DM	2.6				1
Ash	% DM	4.5				1
Gross energy	MJ/kg DM	19.0				*

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, Ruminant	%	89.1				*

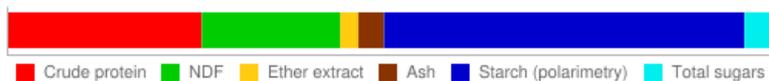
Pig nutritive values	Unit	Avg	SD	Min	Max	Nb
Energy digestibility, growing pig	%	65.6				*
DE growing pig	MJ/kg DM	12.4				*

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

References

Tracy et al., 1918

Last updated on 24/10/2012 00:45:17

Velvet bean (*Mucuna pruriens*), seeds

Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	90.8	2.5	88.5	94.7	8
Crude protein	% DM	27.7	5.2	18.2	37.0	9
Crude fibre	% DM	7.8	1.8	4.8	9.5	6
NDF	% DM	19.8	7.5	14.6	28.4	3
ADF	% DM	7.5		6.0	9.1	2
Lignin	% DM	0.9	0.8	0.2	1.8	3
Ether extract	% DM	2.6	1.6	0.7	4.7	7
Ash	% DM	3.7	0.5	3.0	4.6	8
Starch (polarimetry)	% DM	51.6				1
Total sugars	% DM	6.6				1
Gross energy	MJ/kg DM	19.2				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	1.9	1.0	1.0	3.0	3
Phosphorus	g/kg DM	4.3	1.2	2.9	5.1	3
Potassium	g/kg DM	8.1				1
Magnesium	g/kg DM	1.9				1

Amino acids	Unit	Avg	SD	Min	Max	Nb
Alanine	% protein	0.7		0.6	0.9	2
Arginine	% protein	3.8	3.6	1.7	7.9	3
Aspartic acid	% protein	1.8		1.7	2.0	2
Cystine	% protein	1.2		0.9	1.5	2
Glutamic acid	% protein	4.4		4.2	4.5	2
Glycine	% protein	4.6				1
Histidine	% protein	1.7	0.4	1.4	2.1	3
Isoleucine	% protein	2.6	1.9	1.4	4.8	3
Leucine	% protein	4.7	2.5	3.1	7.6	3
Lysine	% protein	4.2	2.8	1.7	7.0	4
Methionine	% protein	1.3		1.2	1.3	2
Phenylalanine	% protein	2.7	1.8	1.5	4.8	3
Serine	% protein	0.9		0.9	1.0	2
Threonine	% protein	4.0				1
Tryptophan	% protein	1.0		0.7	1.2	2
Tyrosine	% protein	5.1				1
Valine	% protein	2.8	2.3	1.4	5.5	3

Secondary metabolites	Unit	Avg	SD	Min	Max	Nb
Tannins (eq. tannic acid)	g/kg DM	1.6		0.0	3.3	2

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, Ruminant	%	91.5				*
Energy digestibility, ruminants	%	90.4				*
DE ruminants	MJ/kg DM	17.4				*
ME ruminants	MJ/kg DM	13.9				*
Nitrogen digestibility, ruminants	%	81.0				1

Pig nutritive values	Unit	Avg	SD	Min	Max	Nb
Energy digestibility, growing pig	%	77.8				*
DE growing pig	MJ/kg DM	14.9				*
ME growing pig	MJ/kg DM	14.2				*
NE growing pig	MJ/kg DM	10.3				*

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

References

AFZ, 2011; Belew et al., 2008; Cerighelli et al., 1960; Cirad, 2008; Diaz et al., 2002; French, 1938; Lon-Wo et al., 2002; Ogunji et al., 2003; Oyenuga, 1968; Ravindran et al., 1994

Last updated on 24/10/2012 00:45:17

Datasheet citation

Heuzé V., Tran G., Hassoun P., Renaudeau D., Bastianelli D., 2015. *Velvet bean (Mucuna pruriens)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/270> Last updated on October 13, 2015, 13:42

English correction by Tim Smith (Animal Science consultant) and H  l  ne Thiollet (AFZ)

Image credits

● Scott Zona ● Scott Zona ● Ton Rulkens ● Ton Rulkens ● Scamperdale

[+](#) Share / Save [f](#) [t](#) [r](#)



Velvet bean (*Mucuna pruriens*)

[Description](#) [Nutritional aspects](#) [Nutritional tables](#) [References](#)

References

Aboh, A. B. ; Olaafa, M. ; Dossou-Gbété, G. S. O. ; Dossa, A. D. ; Djagoun, N., 2002. Voluntary ingestion and apparent digestibility of a ration based on *Mucuna pruriens* var. utilis seeds flour completed with forage on rabbits. *Tropicicultura*, 20 (4): 165-169

Aderolu, A. Z. ; Akpabio, V. M., 2009. Growth and economic performance of *Clarias gariepinus* juveniles fed diets containing velvet bean, *Mucuna pruriens*, seed meal. *Afr. J. Aquatic Sci.*, 34 (2):131-135

Adjolohoun, S., 2008. Yield, nutritive value and effects on soil fertility of forage grasses and legumes cultivated as ley pastures in the Borgou region of Benin. Thèse Faculté Universitaire des Sciences Agronomiques de Gembloux

Agbede, J. O. ; Aleto, V. A., 2005. Studies of the chemical composition and protein quality evaluation of differently processed *Canavalia ensiformis* and *Mucuna pruriens* seed flours. *J. Food Comp. Anal.*, 18 (1): 89-103

Akinmutimi, A. H. ; Okwu, N. D., 2006. Effect of quantitative substitution of cooked *Mucuna utilis* seed meal for soybean meal in broiler finisher diet. *Int. J. Poult. Sci.*, 5 (5): 477-481

Ani, A. O., 2008. The feeding value of processed velvet bean (*Mucuna pruriens*) for pullets chicks. *J. Trop. Agric. Food Environ. Ext.*, 7 (2): 149-155

Armstrong, K. L. ; Albrecht, K. A. ; Lauer, J. G. ; Riday, H., 2008. Intercropping corn with lablab bean, velvet bean, and scarlet runner bean for forage. *Crop Science*, 48 (1): 371-379

Axtmayer, J. H. ; Rivera Hernandez, G. ; Cook, D. H., 1938. The nutritive value of some forage crops of Puerto Rico. II. Legumes, grasses and mixtures. *J. Agric. Univ. P. Rico*, 22 (4): 445-461

Ayala-Burgos, A.J. ; Herrera-Díaz, P.E. ; Castillo-Caamal, J.B. ; Rosado-Rivas, C.M. ; Osornio-Muñoz, L. ; Castillo-Caamal, A.M., 2003. Rumen degradability and chemical composition of the velvet bean (*Mucuna* spp.) grain and husk. *Trop. Subtrop. Agroecosyst.*, 1 (2-3):71-75

Baligar, V. C. ; Fageria, N. K., 2007. Agronomy and physiology of tropical cover crops. *J. Plant Nutr.*, 30 (8): 1287-1339

Behura, N. C. ; Sahoo, N. ; Satpathy, S., 2006. Antinematodal activity of pod hairs of *Mucuna prurita* in buffalo calves. *Ind. Vet. J.*, 83 (6): 673-674

Bien-Aimé, A. ; Denaud, L., 1989. Velvet bean leaves and sugarcane juice for rabbit supplementation in Haiti. *Livest. Res. Rural Dev.*, 1 (1): 31-35

Buckles, D. ; Triomphe, B. ; Sain, G., 1998. Cover crop in hillside agriculture: farmer innovation with *Mucuna*. IDRC/CIMMYT 1998

Buckles, D. ; Triomphe, B., 1999. Adoption of mucuna in the farming systems of northern Honduras. *Agroforestry Systems*, 47: 67-91

Carew, L. B. ; Gernat, A. G., 2006. Use of velvet beans, *Mucuna* spp., as a feed ingredient for poultry: a review. *World Poult. Sci. J.*, 62: 131-144

Castillo-Caamal, A. M. ; Castillo-Caamal, J. B. ; Ayala-Burgos, A. J., 2003. *Mucuna* bean (*Mucuna* spp.) supplementation of growing sheep fed with a basal diet of napier grass (*Pennisetum purpureum*). *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 107-111

Castillo-Caamal, J.B. ; Jiménez-Osornio, J.J. ; López-Pérez, A. ; Aguilar-Cordero, W. ; Castillo-Caamal, A.M., 2003. Feeding *Mucuna* beans to small ruminants of mayan farmers in the Yucatán peninsula. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 113-117

Cerighelli, R. ; Busson, F. ; Toury, J. ; Bergeret, B., 1960. Contribution à l'étude chimique de quelques légumineuses tropicales utilisées dans l'alimentation. *Ann. Nutr. Alim.*, 14: 161-164

Chikagwa-Malunga, S. K. ; Adesogan, A. T. ; Sollenberger, L. E. ; Badinga, L. K. ; Szabo, N. J. ; Litell, R. C., 2009. Nutritional characterization of *Mucuna pruriens*. 1. Effect of maturity on the nutritional quality of botanical fractions and the whole plant. *Anim. Feed Sci. Technol.*, 148: 34-50

Chikagwa-Malunga, S. K. ; Adesogan, A. T. ; Sollenberger, L. E. ; Badinga, L. K. ; Szabo, N. J. ; Litell, R. C., 2009. Nutritional characterization of *Mucuna pruriens*. 2. *In vitro* ruminal fluid fermentability of *Mucuna pruriens*, *Mucuna* L-dopa and soybean meal incubated with or without L-dopa. *Anim. Feed Sci. Technol.*, 148: 51-67

Chikagwa-Malunga, S. K. ; Adesogan, A. T. ; Szabo, N. J. ; Litell, R. C. ; Phatak, S. C. ; Kima, S. C. ; Arriola, K. G. ; Huisden, C. M. ; Dean, D. B. ; Krueger, N. A., 2009. Nutritional characterization of *Mucuna pruriens*. 3. Effect of replacing soybean meal with *Mucuna* on intake, digestibility, N balance and microbial protein synthesis in sheep. *Anim. Feed Sci. Technol.*, 148: 107-123

Chikagwa-Malunga, S. K. ; Adesogan, A. T. ; Sollenberger, L. E. ; Phatak, S. C. ; Szabo, N. J. ; Kima, S. C. ; Huisden, C. M. ; Litell, R. C., 2009. Nutritional characterization of *Mucuna pruriens*. 4. Does replacing soybean meal with *Mucuna pruriens* in lamb diets affect ruminal, blood and tissue L-dopa concentrations?. *Anim. Feed Sci. Technol.*, 148: 124-137

Cino, D. M. ; Diaz, M. F. ; Lon-Wo, E. ; Gonzalez, A., 1999. Economical evaluation of raw legume grain meals and their potential use in poultry feeding. *Rev. Cubana Cienc. Agric.*, 33 (3): 127-133

Contreras-Govea, F. E. ; Muck, R. E. ; Armstrong, K. L. ; Albrecht, K. A., 2009. Nutritive value of corn silage in mixture with climbing beans. *Anim. Feed Sci. Technol.*, 150: 1-8

Cook, B. G. ; Pengelly, B. C. ; Brown, S. D. ; Donnelly, J. L. ; Eagles, D. A. ; Franco, M. A. ; Hanson, J. ; Mullen, B. F. ; Partridge, I. J. ; Peters, M. ; Schultze-Kraft, R., 2005. Tropical forages. CSIRO, DPI&F(Qld), CIAT and ILRI, Brisbane, Australia

Dahouda, M. ; Toleba, S. S. ; Youssao, A. K. I. ; Mama Ali, A. A. ; Dangou-Sapoho, R. K. ; Ahounou, S. G. ; Hambuckers, A. ; Hornick, J.-L., 2009. The Effects of Raw and Processed *Mucuna pruriens* Seed Based Diets on the Growth Parameters and Meat Characteristics of Benin Local Guinea Fowl (*Numida meleagris*, L). *Int. J. Poult. Sci.*, 8 (9): 882-

Automatic translation

Sélectionner une langue

Feed categories

All feeds

Forage 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

- Dahouda, M. ; Toléba, S. S. ; Senou, M. ; Youssao, A. K. I. ; Hambuckers, A. ; Hornick J-L., 2009. Les ressources alimentaires non-conventionnelles utilisables pour la production aviaire en Afrique : valeurs nutritionnelles et contraintes. *Ann. Méd. Vét.*, 153 (1): 5-21
- Del Carmen, J. ; Gernat, A. G. ; Myrman, R. ; Carew, L. B., 1999. Evaluation of raw and heated velvet beans (*Mucuna pruriens*) as feed ingredients for broilers. *Poult. Sci.*, 78 (6): 866-872
- Delgado, D. C. ; La O, O. ; Chongo, B., 2007. Bromatological composition and *in situ* ruminal degradability of tropical legumes with perspectives of use in cattle productive systems. *Cuban J. Agric. Sci.*, 41 (4): 323-326
- Deshpande, S. S. ; Damodaran, S., 1989. Structure-Digestibility relationship of legume 7S proteins. *J. Food Sci.*, 54: 108-113
- Devendra, C. ; Göhl, B. I., 1970. The chemical composition of Caribbean feedingstuffs. *Trop. Agric. (Trinidad)*, 47 (4): 335
- Dovonou, H. ; Gokou, G. ; Adoukpé, R., 1998. Dynamique de la culture de *Mucuna pruriens* dans la commune rurale de Gakpé, au Bénin. In: Cover crops in West Africa contributing to sustainable agriculture. Buckles, D.; Eteka, A.; Osiname, O.; Galiba, M.; Galiano, G. (Eds). International development research Center, Ottawa, Canada
- Ecocrop, 2011. Ecocrop database. FAO
- Eilittä, M. ; Carsky, R. J., 2003. Efforts to improve the potential of *Mucuna* as a food and feed crop: background to the workshop. *Trop. Subtrop. Agroecosyst.*, 1: 47-55
- Emenalom, O. O. ; Udedibie, A. B. I. ; Esonu, B. O. ; Etuk, E. B. ; Emenike, H. I., 2004. Evaluation of unprocessed and cracked, soaked and cooked velvet beans (*Mucuna pruriens*) as feed ingredients for pigs. *Livest. Res. Rural Dev.*, 16: 33
- Emenalom, O. O. ; Udedibie, A. B. I., 2005. Evaluation of different heat processing methods on the nutritive value of *Mucuna pruriens* (Velvet bean) seed meals for broilers. *Int. J. Poult. Sci.*, 4 (8): 543-548
- Emenalom, O. O. ; Udedibie, A. B. I. ; Esonu, B. O. ; Etuk, E. B., 2005. Evaluation of processed velvet bean (*Mucuna pruriens*) as a feed ingredient in starter diets for broiler chickens. *Japan. J. Poult. Sci.*, 42 (4): 301-307
- Emenalom, O. O. ; Udedibie, A. B. I. ; Esonu, B. O. ; Etuk, E. B., 2006. Cooking in local alkaline solution as a method for improving the nutritive value of velvet bean (*Mucuna pruriens*) for broilers. In: Rege, J. E. O.; Nyamu, A. M.; Sendalo, D. (eds). The role of biotechnology in animal agriculture to address poverty in Africa: opportunities and challenges. Proc. 4th All Africa Conf. on Animal Agriculture, Arusha, Tanzania, 20–24 Sept. 2005, 239-245
- Emiola, A. I.; Ologhobo, A. D.; Gous, R. M., 2007. Influence of processing of mucuna (*Mucuna pruriens* var *utilis*) and kidney bean (*Phaseolus vulgaris*) on the performance and nutrient utilization of broiler chickens. *J. Poult. Sci.*, 44 (2): 168-174
- FAO, 2011. Grassland Index. A searchable catalogue of grass and forage legumes. FAO
- Farougou, S. ; Kpodekon, M. ; Tokannou, R. ; Djossou, V. D. ; Akoutey, A. ; Youssao, I. A. K., 2006. Utilisation de la farine de *Mucuna pruriens* (L.) DC dans l'aliment de croissance des pintades (*Numida meleagris*). *Revue Méd. Vét.*, 157 (10): 502-508
- Ferriera, H. A. ; Peña, B. K. ; Gernat, A. G. ; Carew, L. B. ; Matamoros, I. A., 2003. Evaluation of different processing methods of velvet bean (*Mucuna pruriens*) for use as a feed ingredient for broilers. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 277-286
- Flores, M., 1992. El Uso del Frijol de Abono (*Mucuna* Spp.) Como Cultivo de Cobertura en Plantaciones de Cítricos. Informe Técnico, 7. CIDICCO (Centro Internacional de Información Sobre Cultivos de Cobertura), Honduras.
- Flores, M., 1993. El uso del frijol terciopelo por agricultores de la costa norte de Honduras para producir maíz. Informe Técnico, 1. 2a edición, CIDICCO (Centro Internacional de Información sobre cultivos de cobertura)
- French, M. H., 1938. The nutritive value of velvet beans. *Rep. vet. Dep., Tanganyika*, p. 43-45
- Göhl, B., 1982. Les aliments du bétail sous les tropiques. FAO, Division de Production et Santé Animale, Roma, Italy
- Harms, R. H. ; Simpson, C. F. ; Waldroup, P. W., 1961. Influence of feeding various levels of velvet beans to chicks and laying hens. *J. Nutr.*, 75 (1): 127-131
- Hellin, J., 2006. Better land husbandry: from soil conservation to holistic land management. Land reconstruction and management. Science Publishers
- Hertrampf, J. W.; Piedad-Pascual, F., 2000. Handbook on ingredients for aquaculture feeds. Kluwer Academic Publishers, 624 pp.
- ILRI, 2004. Sustainable crop - livestock production for improved livelihoods and natural resource management in West Africa. Proceedings of an international conference held at the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria, 19-22 November 2001
- Iyayi, E. A. ; Taiwo, V. O., 2003. The effect of incorporating *Mucuna* (*Mucuna pruriens*) seed meal on the performance of laying hens and broilers. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 239-246
- Iyayi, E. A. ; Kluth, H. ; Rodehutscord, M., 2006. Precaecal crude protein digestibility, organs relative weight and performance in broilers fed diets containing *Enterolobium cyclocarpum* and *Mucuna pruriens* seed flour in place of soybean meal. *Arch. Geflügelk.*, 70 (4): 161-167
- Iyayi, E. A. ; Kluth, H. ; Rodehutscord, M., 2006. Chemical composition, antinutritional constituents, precaecal crude protein and amino acid digestibility in three unconventional tropical legumes in broilers. *J. Sci. Food Agric.*, 86 (13): 2166-2171
- Iyayi, E. A. ; Kluth, H. ; Rodehutscord, M., 2008. Effect of heat treatment on antinutrients and precaecal crude protein digestibility in broilers of four tropical crop seeds. *Int. J. Food Sci. Technol.*, 43 (8): 610-616
- Juma, H. K. ; Abdulrazak, S. A. ; Muinga, R. W. ; Ambula, M. K., 2006. Evaluation of *Clitoria*, *Gliricidia* and *Mucuna* as nitrogen supplements to Napier grass basal diet in relation to the performance of lactating Jersey cows. *Livest. Sci.*, 103 (1-2): 23-29
- Lizama, W. T. ; Ricalde, R. S. ; Belmar, R. ; Anderson, S. ; Sundrum, A., 2003. Digestibility and nitrogen retention in creole pigs and improved breed of pigs fed with maize and mucuna beans in peasant systems in South Mexico. Deutscher Tropentag, October 8-10, 2003, Göttingen. Technological and institutional innovations for sustainable rural development, Göttingen, Germany
- Lorenzetti, F. ; MacIsaac, S. ; Arnason, J. T. ; Awang, D. V. C. ; Buckles, D., 1998. The phytochemistry, toxicology, and food potential of velvetbean (*Mucuna* Adans. spp., Fabaceae). In: Cover crops in West Africa contributing to sustainable agriculture. Buckles, D.; Eteka, A.; Osiname, O.; Galiba, M.; Galiano, G. (Eds). International development research Center, Ottawa, Canada

- Mapiye, C. ; Mwale, M. ; Mupangwa, J. F. ; Mugabe, P. H. ; Poshiwa, X. ; Chikumba, N., 2007. Utilisation of ley legumes as livestock feed in Zimbabwe. *Trop. Grassl.*, 41: 84-91
- Martinez Perez, M. ; Sarmiento Franco, L. ; Santos Ricalde, R. ; Rodriguez Alonso, Z. ; Capetillo leal, C. ; Savon Valdes, L. ; Segura Correa, J., 2008. Protein and Amino Acid Apparent Ileal Digestibility in Broilers Fed *Mucuna deeringiana* [Bort Merr.] Foliage Meal in the Diet. *J. Anim. Vet. Adv.*, 7 (6): 669-672
- Matenga, V. R. ; Ngongoni, N. T. ; Titterton, M. ; Maasdorp, B. V., 2003. *Mucuna* seed as a feed ingredient for small ruminants and effect of ensiling on its nutritive value. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 97-105
- Mbuthia, E. W. ; Gachuri, C. K., 2003. Effect of inclusion of *Mucuna pruriens* and *Dolichos lablab* forage in napier grass silage on silage quality and on voluntary intake and digestibility in sheep. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 123-128
- Mendoza-Castillo, H. ; Castillo-Caamal, J. B. ; Ayala-Burgos, A., 2003. Impact of *Mucuna* bean (*Mucuna* spp.) Supplementation on milk production of goats. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 93-96
- Miller, I. L., 2000. Cow Itch or Pica-pica. *Agnote*
- Muinga, R. W. ; Saha, H. M. ; Mureithi, J. G., 2003. The effect of mucuna (*Mucuna pruriens*) forage on the performance of lactating cows. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 87-91
- Mureithi, J. G. ; Gachene, C. K. K. ; Wamuongo, J. L. W., 2003. Legume cover crops research in Kenya: experiences of the legume research network project: highlights of phases 1 research activities (1994-2000). KARI Technical Note Series, 12
- Murungweni, E. C. ; Mabuku, O. ; Manyawu, G. J., 2004. *Mucuna*, Lablab and Paprika Calyx as Substitutes for Commercial Protein Sources used in Dairy and Pen-fattening Diets by Smallholder Farmers of Zimbabwe. In: Tropical legumes for sustainable farming systems in southern Africa and Australia, Whitbread, A. M.; Pengelly, B. C. (Eds). ACIAR Proceedings No. 115
- Naik, A. H., 1967. Chemical composition of Tanzania feedingstuffs. *E. Afr. Agric. For. J.*, 32 (2): 201-205
- Nyambati, E. M. ; Sollenberger, L. E. ; Kuncle, W. E., 2003. Feed intake and lactation performance of dairy cows offered napier grass supplemented with legume hay. *Livest. Prod. Sci.*, 83: 179-189
- Nyirenda, D. ; Musukwa, M. ; Jonsson, L. O., 2003. The effects of different processing methods of velvet beans (*Mucuna pruriens*) on L-dopa content, proximate composition and broiler chicken performance. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 253-260
- Obeid, J. A. ; Cruz, M. E., 1989. Corn crop grown with and without tropical legumes for silage making. Proceedings of the XVI International Grassland Congress, 4 11 October 1989, Nice, France. 1989, 959 960
- Ogunji, J. O. ; Wirth, M. ; Osuigwe, D. I., 2003. Nutrient composition of some tropical legumes capable of substituting fish meal in fish diets. *J. Agric. Rural Dev. Trop. Subtrop. (Der Tropenlandwirt)*, 104 (2): 143-148
- Oyenuga, V. A., 1968. Nigeria's foods and foodstuffs. Ibadan, University Press
- Pengelly, B. C. ; Whitbread, A. ; Mazaiwana, P. R. ; Mukombe, N. ; , 2004. Tropical forage research for the future - Better use of research resources to deliver adoption and benefits to farmers. In: Tropical legumes for sustainable farming systems in southern Africa and Australia. Whitbread, A. M. and Pengelly, B. C. (Eds). ACIAR, Canberra
- Pérez-Hernandez, F. ; Ayala-Burgos, A. J. ; Belmar-Casso, R., 2003. Performance of growing lambs supplemented with *Mucuna pruriens*. *Trop. Subtrop. Agroecosyst.*, 1: 119-122
- Prasad, S. K. ; Qureshi, T. N. ; Qureshi, S., 2008. *Mucuna pruriens* seed powder feeding influences reproductive conditions and development in Japanese quail *Coturnix coturnix japonica*. *Animal*, 3 (2): 261-268.
- Pugalenth, M. ; Vadivel, V. ; Siddhuraju, P., 2005. Alternative food/feed perspectives of an underutilized legume *Mucuna pruriens* var. *utilis* — A review. *Plant Foods Hum. Nutr.*, 60: 201-218
- Ravindran, V., 1988. Observations on the forage potential of velvet bean. *J. Natn. Sci. Coun. Sri Lanka*. 16 (2): 175-181
- Sandoval Castro, C. A. ; Herrera, P. ; Capetillo Leal, C. M.; Ayala Burgos, A. J., 2002. *In vitro* gas production and digestibility of mucuna bean. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 77-80
- Savon, L. ; Scull, I. ; Orta, M. ; Torres, V., 2004. Physicochemical characterization of the fibrous fraction of five tropical foliage meals for monogastric species. *Cuban J. Agric. Sci.*, 38 (3)
- Siddhuraju, P. ; Becker, K. ; Makkar, H. P. S., 2000. Studies on the nutritional composition and antinutritional factors of three different germplasm seed materials of an under-utilized tropical legume, *Mucuna pruriens* Var. *Utilis*. *J. Agric. Food Chem.*, 48: 6048-6060
- Siddhuraju, P. ; Becker, K., 2001. Preliminary nutritional evaluation of *Mucuna* seed meal (*Mucuna pruriens* var. *utilis*) in common carp (*Cyprinus carpio* L.): an assessment by growth performance and feed utilisation. *Aquaculture*, 196 (1-2):105-123
- Siddhuraju, P. ; Becker, K., 2002. Effect of phenolic nonprotein amino acid L-dopa (L-3,4-dihydroxyphenylalanine) on growth performance, metabolic rates and feed nutrient utilization of common carp (*Cyprinus carpio* L.). *Aquacult. Nutr.*, 8 (1): 69-77
- Siddhuraju, P. ; Becker, K., 2003. Comparative nutritional evaluation of differentially processed mucuna seeds [*Mucuna pruriens* (L.) DC. var. *utilis* (Wall ex Wight) Baker ex Burck] on growth performance, feed utilization and body composition in Nile tilapia (*Oreochromis niloticus* L.). *Aquacult. Res.*, 34 (6): 487-500
- Siddhuraju, P. ; Becker, K., 2005. Nutritional and antinutritional composition, *in vitro* amino acid availability, starch digestibility and predicted glycemic index of differentially processed mucuna beans (*Mucuna pruriens* var. *utilis*): an under-utilised legume. *Food Chem.*, 91: 275-286
- Sidibé-Anago, A. G. ; Ouedraogo, G. A. ; Kanwé, A. B. ; Ledin, I., 2009. Foliage yield, chemical composition and intake characteristics of three *Mucuna* varieties. *Trop. Subtrop. Agroecosyst.*, 10: 75-84
- Smith, O. B. ; Idowu, O. A. ; Asaolu, V. O. ; Odunlami, O., 1991. Comparative rumen degradability of forages, browse, crop residues and agricultural by products. *Livest. Res. Rural Dev.*, 3 (2): 59-66
- Sridhar, K. R. ; Bhat, R., 2007. Agrobotanical, nutritional and bioactive potential of unconventional legume - *Mucuna*. *Livest. Res. Rural Dev.*, 19: 126
- Szabo, N. J., 2003. Indolealkylamines in *Mucuna pruriens*. *Trop. Subtrop. Agroecosyst.*, 1: 295-307
- Taiwo, A. A. ; Adejuyigbe, A. D. ; Talabi, E. O. ; Okumakuma, G. ; Adebowale, E. A., 2006. Effect of raw and cooked mucuna seed meal based diets on the performance, nutrient digestibility and haematology of weaned rabbits. *Nigerian J. Anim. Prod.*, 33 (1-2): 209-215
- Takahashi, M. ; Ripperton, J. C., 1949. Koa haole (*Leucaena glauca*): its establishment, culture, and utilization as a forage crop. *Hawaii Agric. Exp. Sta. Bull.*, 100
- Tracy, S. M. ; Coe, H. S., 1918. Velvet beans. United States Department of Agriculture, Washington, DC, USA. Farmers

Bulletin 962

- Trejo, L. W. ; Santos, R. ; Hau, E. ; Olivera, L. ; Anderson, S. ; Belmar R., 2004. Utilisation of mucuna beans (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt) to feed growing broilers. *J. Agric. Rural Develop. Tropics Subtropics*, 105 (2): 155-164
- Tuleun, C. D. ; Igba, F., 2008. Growth and carcass characteristics of broiler chickens fed water soaked and cooked velvet bean (*Mucuna utilis*) meal. *Afr. J. Biotech.*, 7 (15): 2676-2681
- Tuleun, C. D. ; Carew, S. N. ; Aji, I., 2008. Feeding value of velvet beans (*Mucuna utilis*) for laying hens. *Livest. Res. Rural Dev.*, 20 (5)
- Tuleun, C. D. ; Igyem, S. Y. ; Adenkola, A. Y., 2009. The feeding value of toasted mucuna seed meal diets for growing Japanese quail (*Coturnix coturnix japonica*). *Int. J. Poult. Sci.*, 8 (11): 1042-1046
- Tuleun, C. D. ; Patrick, J. P. ; Tihamiyu, L. O., 2009. Evaluation of raw and boiled velvet bean (*Mucuna utilis*) as feed ingredient for broiler chickens. *Pakistan J. Nutr.*, 8 (5): 601-606
- Tuleun, C. D. ; Offia, B. ; Yaakugh, I. D. I., 2010. Comparative performance of broiler fed diets containing raw and processed mucuna seed meal. *Int. J. Poult. Sci.*, 9 (11): 1056-1062
- Tuleun, C. D. ; Dashe, N. A., 2010. Effect of dietary levels of toasted mucuna seed meal (TMSM) on the performance and egg quality parameters of laying Japanese quails (*Coturnix coturnix japonica*). *Int. J. Poult. Sci.*, 9 (12): 1092-1096
- Ukachukwu, S. N. ; Obioha, F. C. ; Madubuike, R. C., 1999. Determination of the true metabolizable energy (TME) of raw and heat-treated *Mucuna cochinchinensis* using adult broilers. *Trop. J. Anim. Sci.*, 3 (1): 25-31
- Ukachukwu, S. N. ; Szabo N. J., 2003. Effect of processing, additives and vitamin B6 supplementation of *Mucuna pruriens* var *cochinchinensis* on broilers. *Trop. Subtrop. Agroecosyst.*, 1 (2-3): 227-237
- Ukachukwu, S. N. ; Obioha, F. C., 2007. Effect of processing methods on the nutritional value of *Mucuna cochinchinensis* to broiler chicks. *Aust. J. Exp. Agric.*, 47 (2): 125-131.
- Ukachukwu, S. N. ; Uzoach, S. O. ; Obiefuna, J. N., 2007. Aspects of growth performance and nutrient retention of starter broilers fed *Mucuna cochinchinensis*-based diets supplemented with methionine. *Aust. J. Exp. Agric.*, 47 (2): 132-135
- Ukachukwu, S. N., 2007. Optimum inclusion and replacement value of boiled *Mucuna cochinchinensis* for soybean meal in broiler diets. *Aust. J. Exp. Agric.*, 47 (6): 672-676.
- US Forest Service, 2011. *Mucuna pruriens* (L.) DC.. Pacific Island Ecosystems at Risk (PIER)
- Vadivel, V. ; Pugalenti, M., 2007. Biological value and protein quality of raw and processed seeds of *Mucuna pruriens* var. *utilis*. *Livest. Res. Rural Dev.*, 19 (7): 97
- Vadivel, V. ; Pugalenti, M., 2010. Studies on the incorporation of velvet bean (*Mucuna pruriens* var. *utilis*) as an alternative protein source in poultry feed and its effect on growth performance of broiler chickens. *Trop. Anim. Health Prod.*, 42 (7): 1367-1376
- Vadivel, V. ; Pugalenti, M. ; Doss, M. ; Parimelazhagan, T., 2011. Evaluation of velvet bean meal as an alternative protein ingredient for poultry feed. *Animal*, 5 (1): 67-73
- van Eys, J. E. ; Offner, A. ; Back, A., 2004. Manual of quality analyses for soybean products in the feed industry. American soybean association
- Walker, C. A., 1975. Personal communication. Central Research Station, Mazabuka, N. Rhodesia
- Wolf, B. ; Snyder, G. H., 2003. Sustainable soils: the place of organic matter in sustaining soils and their productivity. Routledge, Taylor & Francis Group
- Wulijarni-Soetjipto, N. ; Maligalig, R. F., 1997. *Mucuna pruriens* (L.) DC. cv. group *Utilis*. Record from Proseabase. Faridah Hanum, I ; van der Maesen, L.J.G. (Editors). PROSEA (Plant Resources of South-East Asia) Foundation, Bogor, Indonesia

111 references found

Datasheet citation

Heuzé V., Tran G., Hassoun P., Renaudeau D., Bastianelli D., 2015. *Velvet bean (Mucuna pruriens)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/270> Last updated on October 13, 2015, 13:42

English correction by Tim Smith (Animal Science consultant) and H el ene Thiollet (AFZ)

Image credits

● Scott Zona ● Scott Zona ● Ton Rulkens ● Ton Rulkens ● Scamperdale

