

## Neem (*Azadirachta indica*)

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

Neem, neem tree, Indian lilac, margosa, nimtree [English]; margousier, margosier, neem [French]; nim, margosa, lila india [Spanish]; amargosa [Portuguese]; Niembaum [German]; mimba [Indonesian]; mwarobaini [Kiswahili]; sàu đầu [Vietnamese]; نيم شائع [Arabic]; [Bengali]; [Burmese]; [Gujarati]; אדרכת הודית [Hebrew]; [Hindi]; इन्दोसेन्दान [Japanese]; [Kannada]; [Marathi]; [Mayalayam]; [Nepalese]; [Pendjabi]; نيم [Western punjabi]; چریش [Persian]; Ним [Russian]; [Tamil]; สะเดา [Thai]

### Products:

- Neem leaves, neem foliage
- Neem seed cake, neem seed oil cake, neem seed kernel cake

### Species

*Azadirachta indica* A. Juss. [Meliaceae]

### Synonyms

*Antelaea azadirachta* (L.) Adelb., *Melia azadirachta* L.

### Feed categories

- Oil plants and by-products
- Other forage plants
- Plant products and by-products

### Related feed(s)

- Chinaberry (*Melia azedarach*)

### Description

Neem (*Azadirachta indica* A. Juss.) is a multipurpose tree that is highly popular in India, where it provides food and insecticide, and is used for its great number of ethnomedicinal properties. Neem leaves and the oil cake resulting from oil extraction can be used for livestock feeding, but the raw cake is poorly palatable, toxic and requires processing.

### Morphology

Neem is a medium-sized tree, reaching 15 to 30 m in height, with a large rounded crown up to 10-20 m in diameter. It is mainly evergreen but sometimes shed its leaves during the dry season (Orwa et al., 2009; Puri, 1999). Neem has a deep taproot and is a mycorrhizal-dependent species. The bark is grey, becomes fissured and flakes in old trees. A sticky foetid sap exudates from old trees in humid climates (Orwa et al., 2009; Puri, 1999). The branches are numerous and spreading. The leaves are alternate, petiolated, clustered at the end of the branches, unequally pinnate, glabrous and dark glossy green at maturity, 20-40 cm in length and bearing 10-20 leaflets (FAO, 2015). The leaflets are 5-10 cm long x 1.2-4 cm broad, sickle-shaped and slightly denticulate (FAO, 2015; Orwa et al., 2009; Puri, 1999). The flowers are numerous, fragrant, white and borne in large clusters (up to 30 cm long). Neem fruits are 1-2 cm long drupes, smooth and green with white milky juice when unripe, turning to yellow to brown when mature. They have a thin epicarp, a mucilaginous fleshy mesocarp and a hard endocarp. They contain a variable number of ovoid (1-2 cm) oil seeds (Orwa et al., 2009; Puri, 1999).

### Utilisation

Neem is a multipurpose tree. People consume its fruits raw or cooked, and sometimes eat the young twigs and flowers as vegetables (Orwa et al., 2009). Neem leaves, bark and seed extracts have been used for centuries in India in ethnomedicine and ethnoveterinary medicine (Biswas et al., 2002; Subapriya et al., 2005). The seeds are an important source of azadirachtin, a limonoid compound (triterpenoid) present in the seeds, and also to some extent in leaves and other tissues. It acts as an insect repellent, inhibiting them from feeding, thus disrupting their growth, metamorphosis and reproduction (Orwa et al., 2009). Extracts or crude parts of the tree are often mixed with stored seeds such as maize, rice and beans, in order to protect them against insects (Boeke et al., 2004). In India, neem-based pesticides have been developed (Orwa et al., 2009). Neem extracts can protect plants from foliage-eating insects without affecting pollinating insects such as honeybees. Other neem limonoids have various properties. Melantriol and salannin act as antifeedants for insects. Nimbin and nimbindin (the latter a bitter compound present in the seed at 2%) were reported to have antiviral activity (Bostid, 1992). The oil extracted from the seeds has industrial uses and is widely used in ethnomedicine in India. However, it contains various toxic substances (including some added to increase its alleged therapeutic effect) and has been the cause of the death of children (Jindal et al., 2012; Sundaravalli et al., 1982). Neem provides valuable firewood, makes good charcoal and provides various environmental services (Orwa et al., 2009) (see **Environmental impact** below).

#### 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

The use of neem products for animal feeding remains limited. While neem leaves can be an occasional forage for ruminants and rabbits, neem seed oil cake, resulting from oil extraction of whole seeds (neem seed cake), or decorticated seeds (neem seed kernel cake), is usually considered as a non-edible oil cake only to be used as organic nitrogenous fertilizer (Ramachandran et al., 2007). Neem seed cake is a protein-rich ingredient and its use by farmers has been recorded, for instance in Southern India (Christopher, 1970). However, its unpalatability and toxicity have prevented its widespread use in livestock feeding. This product has been described as a promising potential feed ingredient since the 1970s and there have been a considerable number of attempts at rendering it suitable for livestock. While some detoxification processes do work in the laboratory, the most recent review considered that there were still many technical, economical and food safety issues to be solved before these products could be recommended for livestock (Dutta et al., 2012).

## Distribution

Neem is native of dry areas of the Indian subcontinent, Myanmar and China (Rojas-Sandoval et al., 2014). It was naturally distributed in Thailand, Malaysia and Indonesia and has become one of the most widespread trees in tropical and subtropical areas. It has become invasive in the Caribbean (Puerto Rico, Dominican Republic), sub-Saharan Africa (Kenya, Gambia, Senegal, Guinea Bissau, Ghana, Tanzania), and the Pacific (Australia, Fiji, Marshall Islands) (Rojas-Sandoval et al., 2014).

Neem naturally occurs in dry deciduous and thorn forests, or acacia forests. In its exotic range, it has become invasive in a number of habitats including fallow agricultural land, savannah, and dry arid forests (coastal forest in Ghana, lowland monsoon forest in Indonesia, evergreen and dry deciduous forest in Africa) (Orwa et al., 2009). Neem can be found from sea level up to an altitude of 1500 m in places where average annual rainfall ranges from 400 to 1200 mm and where average annual maximum temperatures may be as high as 40°C. Adult trees tolerate some frost but seedlings are sensitive to it. Neem can grow on a wide range of soils, from acidic to alkaline pH, but it does better on shallow, stony, sandy, poor soils, in marginal sloping places or on rocky crevices (Puri, 1999). Neem is a full sunlight species but it can withstand some shade in its first years (Orwa et al., 2009). Neem is able to extract nutrients from highly leached sandy soils and can survive extreme pH conditions, from 3 to 9 (Rojas-Sandoval et al., 2014). In well-drained soils, neem withstands up to 2500 mm rainfall. Neem has some tolerance of salinity and has been used in sugarcane plantations with a significant soil salinity (Orwa et al., 2009; Ahmed et al., 1997).

## Processes

Because of the toxicity of neem seed cake, many processes have been investigated since the 1970s to reduce its antinutritional effects on livestock. Water washing, methanol extraction, urea and alkali treatments have all shown promising results. However, the standardisation of those techniques, their economic feasibility and the effect of such processes in meat, egg and dairy products have not yet been thoroughly investigated (Abbeddou et al., 2012; Dutta et al., 2012).

## Forage management

A mature neem tree can produce 350 kg of leaves per year (Göhl, 1982).

## Environmental impact

### Erosion control and soil improver

Neem is suitable for dune fixation and for soil reclamation in areas where salinity occurs. Neem seed cake is used as an organic manure that improves the efficiency of added N fertilizer as it delays the nitrification of soil. Neem leaves and small twigs can be used as mulch. In Burkina Faso, mulch made with neem leaves increased the yield of sorghum grain by 0.5 t/ha/year (Orwa et al., 2009; Tilander et al., 1997).

### Shade, shelter and afforestation

Neem is a valuable shade tree that is particularly appreciated in India where it is planted on avenues, along roads and in villages (Orwa et al., 2009). It provides a good windbreak but, in the Philippines, it does not survive typhoons (Ahmed et al., 1997). In Haiti, it has been suggested to use neem for afforestation (Bostid, 1992).

### Intercropping

In India, intercropping neem with pearl millet (*Pennisetum glaucum*) gave good results (Orwa et al., 2009).

## Datasheet citation

Heuzé V., Tran G., Archimède H., Bastianelli D., Lebas F., 2015. *Neem (Azadirachta indica)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/182>. Last updated on October 2, 2015, 15:40

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

## Image credits

● Forest & Kim Starr ● Tu7uh ● CostaPPPR ● Mokie ● Qniemiec

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



## Neem (*Azadirachta indica*)

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

### Nutritional attributes

#### Neem leaves

Neem leaves have a moderate to good protein content (12-20% DM), moderate NDF and ADF contents but a high level of lignin (10-15% DM). Neem leaves contain high amounts of calcium but low amounts of phosphorus.

#### Neem seed cake and neem seed kernel cake

The chemical composition of neem seed cake varies greatly depending on several factors. Neem seed cakes obtained from whole seeds have a relatively low protein content (12-20% DM) and a high fibre content (crude fibre 18-30% DM). Neem seed kernel cake, obtained from decorticated seeds, has a much higher protein content (34-41% DM) and a lower fibre content (11-17% DM). Oil content depends on the method of extraction and ranges from less than 1% to more than 10% DM. Cakes obtained from partially de-pulped and decorticated seeds are intermediate depending upon the degree of de-pulping and/or decortication of the seeds ([Dutta et al., 2012](#)).

### Potential constraints

Neem products and by-products contain antinutritional and toxic factors. A comprehensive review of the literature on this aspect published up to 2003 has been written by [Boeke et al., 2004](#).

#### Limonoids

Neem leaves and seeds contain limonoids (azadirachtin, salanin, nimbin, nimbidiol, etc.), which are triterpenoid compounds that are both bitter and toxic to many animal species.

#### Neem leaves and neem leaf extracts

Neem leaves contain large amounts of tannins (11%) and saponins (2.5%). In ruminants, condensed tannins and saponins may be used to improve rumen ecology ([Suchitra et al., 2008](#)), but they are detrimental in monogastric species. Neem leaves have been shown to be toxic in humans and many animal species. Traditional neem leaf-based medicines taken to treat febrile illness, abdominal upset or to induce abortion or infertility had been shown to have acute toxic effects in humans ([Boeke et al., 2004](#)). Acute toxicity followed by death was reported in a sheep that ate neem leaves ([Ali et al., 1982](#)). Subacute and semi-chronic effects on male reproduction have been reported in rats ([Boeke et al., 2004](#)). Leaves fed to poultry at 2-5% of the diet resulted in many histopathological changes ([Ibrahim et al., 1992a](#)).

Alcoholic extracts of neem leaves (obtained with solvents such as ethanol, methanol, etc.) have been found toxic in mice, rats and rabbits ([Boeke et al., 2004](#)). Aqueous extracts (obtained after soaking the plant into water) were reported to cause health problems in goats and guinea pigs at levels above 50 mg/kg BW. At higher doses, goats had tremors and ataxia with histopathological lesions ([Ali, 1987](#)). In chicks, the LD<sub>50</sub> for aqueous extracts was 4800 mg/kg BW ([Biu et al., 2010](#)).

#### Neem oil

Though neem oil is widely used in traditional pharmacopoeia, several cases of morbidity and mortality have been reported in humans. Ingestion of neem oil has been associated with toxic encephalopathy, Reye's syndrome and metabolic acidosis ([Jindal et al., 2012](#); [Sundaravalli et al., 1982](#)). Many studies have observed acute and subacute toxicity of neem oil in rats, mice and rabbits. Doses of 14 and 24 mL/kg BW for rats and rabbits, respectively, resulted in acute toxicity, though one long-term study on rats fed 10% neem oil over 3 generations found the oil safe ([Boeke et al., 2004](#)). Processed oil (hydrogenated, treated with KOH, solvent extracted) might be safer ([Reddy et al., 1988](#) cited by [Puri, 1999](#); [Rukmini, 1987](#)).

#### Neem seeds and fruits

Chicks fed on neem fruits were reported to suffer from hepato-nephropathy ([Ibrahim et al., 1992b](#)). Seed extracts have been reported toxic in rats ([Boeke et al., 2004](#)).

### Ruminants

#### Neem leaves

Neem leaves can be browsed or cut, dried and ground into leaf meal to be included in a concentrate diet ([Puri, 1999](#)). Fallen leaves may be used as fodder but they are less palatable. Neem leaves have been described as the forage of choice during dry periods and drought. For instance, in Gujarat, India, 15-20 kg/d of neem leaves were fed to cattle and buffalo during a famine in 1976 ([Ketkar, 1976](#) cited by [Puri, 1999](#)).

#### Palatability

Neem leaves are said to be palatable to camels and goats. In India, DM intakes of about 3% BW were reported in goats ([Amanullah et al., 2006](#); [Bais et al., 2002](#)). During dry periods, neem leaves were palatable to cattle ([Patel et al., 1957](#); [Hentgen, 1985](#) cited by [Puri, 1999](#)).

#### Digestibility

Neem leaves have a relatively low nutritional value. In India, an estimated ME of 8.0 MJ/kg DM was reported ([Ranjhan, 1980](#) cited by [Puri, 1999](#)). In Sudan, the *in vitro* OM digestibility of neem leaves was 51%, comparable to that of a local sorghum

#### 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

hay, but the estimated ME was much higher (10.0 vs. 7.8 MJ/kg DM) (Webb, 1988). In another *in vitro* study, the DM digestibility of neem leaves was 50% (Amanullah et al., 2006).

#### Sheep and goats

In a trial in Thailand, neem foliage was included at 20% in the diet of growing goats as a partial substitute for soybean meal without affecting productive performance, rumen fermentation and N balance (Srisaikhram, 2009). In India, sheep fed on multi-nutrient blocks that contained 30% neem leaves, as a supplement to a sorghum stover-based diet, increased intake and digestibility while blood parameters remained unchanged (Raghuvansi et al., 2007a; Raghuvansi et al., 2007b).

#### Neem seed cake and neem seed kernel cake

Raw neem seed cake is unpalatable and harmful to ruminants as it adversely affects growth, the male reproductive system, and has at times led to haematuria. Consequently it should be fed to ruminants only after it has been detoxified to make it safe and palatable. Many processes have been tested including organic solvent extraction, acid or alkali treatment, water-washing, sun-drying and heating. Inclusion rates of 30-40% or more become feasible, but treatments such as water-washing or alkali treatment may also result in an important loss of nutrients, and the economic viability of such methods has not yet been established (Dutta et al., 2012).

#### Palatability

Numerous trials in India with calves, buffalo bulls, crossbred bulls and sheep have shown that raw neem seed cake is unpalatable to ruminants due to the presence of limonoids. It is possible to improve its palatability by feeding it together with ingredients such as starch, molasses, maize or sugar from palm sap. Urea-ammoniated seed cake was found to be palatable to buffalo and kids (Dutta et al., 2012).

#### Dairy cattle

In crossbred dairy cows, water-washed neem seed kernel cake (protein 41% DM) was included at 40% in the concentrates without depressing DM intake, nutrient digestibility, milk yield, butter fat content and organoleptic evaluation of milk (Nath et al., 1989). Another experiment with 30% water-washed seed cake led to similar positive results. However, it was noted that water-washing was laborious and not feasible for industrial application, besides being uneconomical due to loss of soluble nutrients (Kumar et al., 1992).

#### Growing cattle

Poor palatability, as well as depressed performance and nutrient digestibility, have been observed in crossbred calves fed concentrate mixtures containing 25 or 57% raw neem seed cake, and in buffalo calves fed diets where neem seed cake provided 25 to 50% of the dietary protein (Bedi et al., 1975a; Bedi et al., 1975b cited by Dutta et al., 2012). In crossbred calves, feeding a concentrate containing neem seed cake that contributed to 12.5, 25, or 50% of the crude protein requirement, resulted in poor palatability, reduced nutrient digestibility, poor weight gain or loss of body weight (Aruwayo et al., 2013). Water-washed and sun-dried neem seed kernel cake included at 45% in a concentrate mixture to male calves did not significantly alter growth, DM intake and nutrient digestibility (Nath et al., 1983). Water-washed neem seed kernel cake included at 40% in a concentrate mixture to buffalo calves improved growth but lowered DM and carbohydrate digestibility (Agrawal et al., 1987). In buffalo calves, NaOH-treated and urea-treated neem seed kernel meal could be included at 40% in the diet, as a complete replacement for groundnut meal, with no effect on performance and blood biochemical parameters (Sastry et al., 1999).

#### Sheep and goats

Water-washed neem seed cake was included safely at rates of 30% in sheep diets and 20% in goat diets (Ramu et al., 1994). Likewise, water-washed neem seed kernel cake could be included in the diet of growing goats at up to 25-30% without deleterious effects on nutrient utilization, metabolism, carcass quality and organoleptic characteristics (Verma et al., 1995; Verma et al., 1996). Urea-treated neem seed kernel cake included at 33% in the concentrates for growing lambs was a satisfactory replacement of groundnut cake, though microcalculi were found in the kidneys (Musalia et al., 2000). Urea-ammonia treated neem seed kernel cake could be included at 22.5% in the concentrate for growing goats, replacing groundnut meal, with no effect on performance, and a better feed:gain ratio (Anandan et al., 1999).

## Pigs

#### Neem seed kernel cake

Information on the use of neem seed cake in pigs is scarce. Water-washed neem seed kernel cake could be included in growing pig diets at 10% of the diet (DM basis) to completely replace groundnut meal with no deleterious effects on growth and health parameters (Sastry et al., 1992).

## Poultry

Raw neem seeds and seed cake are not suitable for poultry feeding due to their toxicity and to the presence of bitter compounds that impair feed intake (Gowda et al., 2000b; Uko et al., 2008). Some properties of these compounds make these products potentially valuable in veterinary medicine, for instance against external parasites (Al-Quraishy et al., 2010). Neem seeds or extracts can be used at low incorporation rates in replacement of antibiotics (Kone, 2010; Landy et al., 2011).

#### Broilers

Raw neem seeds and seed cake decrease feed intake and broiler performance. Several processes have been investigated in order to make neem products useful for poultry: soaking, cooking, alkali or acid treatments, and extraction with one or several solvents (Gowda et al., 2000b). Some encouraging results have been obtained at relatively low inclusion rates, such as better feed intake and acceptable performance. Neem seed kernel cake treated with alkali or urea maintained an acceptable level of performance at 13% inclusion in the diet (Nagalakshmi et al., 1996; Nagalakshmi et al., 1999). Toasting or autoclaving alleviated the negative effects of neem kernels and seed kernel meal (Uko et al., 2008). However, the effect of autoclaving was not constant: in some cases no improvement over raw neem products was observed (Uko et al., 2006). Therefore neem seeds and seed cake are not recommended in broiler feeding. These products may be used only in limited amounts (below 5%) after being efficiently detoxified.

#### Layers

Raw neem seed kernel cake induced lower feed intake and laying performance when used at 15 or 20% in layer diets, while at 10% performance was maintained (Gowda et al., 1998b). Neem by-products should be used carefully in layers, given the

possible long term effects on health. In male or female breeders, neem should be strictly avoided because of its potential effects on reproduction (Gowda et al., 2000b; Mohan et al., 1997).

### Quails

In growing quails, incorporation of 5 to 10% solvent-extracted neem kernel meal in the diet decreased growth slightly, while inducing mild pathological effects (Elangovan et al., 2000b). In laying quails, performance was maintained with 5-10% neem kernel meal but feed efficiency was reduced (Elangovan et al., 2000a). The risks of pathological effects suggest avoiding the use of neem products in quail diets.

## Rabbits

### Neem leaves

In Nigeria, dried neem leaves were used safely for growing rabbits up to 15% of the diet (Ogbuewu, 2008; Ogbuewu et al., 2010a). The very high lignin content could be considered as an advantage for the digestive health of rabbits. In rabbit does, the long term feeding of diets with 5 to 15% sun-dried neem leaves (112 days) significantly modified blood parameters (Ogbuewu et al., 2010b) without altering linear body growth and reproductive tract morphometry (Ogbuewu et al., 2011). The digestible energy of neem leaves for rabbits is about 8.0 MJ/kg DM, but protein digestibility is low (about 36%) (Lebas, 2013). Aqueous extracts of neem leaves have recognized hypoglycemic effects in rabbits (Khosla et al., 2000).

### Neem seeds

The toxicity of neem oil has been demonstrated in rats and rabbits, with lungs and the central nervous system as the target organs of toxicity. The 24h DL<sub>50</sub> was established in rabbits as 24 ml/kg BW (Gandhi et al., 1988). Despite this, raw neem seeds can be safely introduced in growing rabbit diets up to 20% corresponding to a daily intake of only 3 ml/kg BW of neem oil, without any alteration of growth performance. A higher proportion (30%) induced significant reductions in feed intake and daily weight gain (Fajinmi et al., 1990). However, when 20% of raw neem kernels (dehulled seeds) were included in the diet, feed intake and growth rate were significantly reduced, but in this case the daily oil intake was 9 ml/kg BW (Bawa et al., 2007).

### Neem seed cake

Neem seed cake was included at 5-10 or 20% of the diet; it was safely fed to growing rabbits at up to 10% in place of groundnut cake (Wasanthakumar et al., 1999a; Wasanthakumar et al., 1999b). A similar conclusion has been obtained with urea-ammonia treated neem kernel cake used to replace completely groundnut cake in the diets of angora rabbits (Gowda et al., 1998a), or growing New Zealand White rabbits (Gowda et al., 2000a).

## Fish

### Neem seed cake

Neem seed cake is not generally used as a feed ingredient for fish. In common carp fingerlings (*Cyprinus carpio*), water-washed neem seed cake included at 10% of the diet decreased feed intake, although at up to 15% there was no negative effect on amylase and protease activity (Lenka et al., 2010).

### Neem leaf extracts

#### Immunostimulatory and antimicrobial activity

Many experiments have evaluated neem leaf extracts (aqueous or alcoholic) for their potential health benefits in fish. Neem leaf extracts had immunostimulatory effects at 5 g/l on Asian seabass (*Lates calcarifer*) infected with the bacterium *Vibrio harveyi* (Talpur et al., 2013), and at 10 g/l in common carp (*Cyprinus carpio*) invaded by the fungus *Aphanomyces invadans* (Harikrishnan et al., 2005). Methanol and ethanol extracted neem leaf was reported to have antimicrobial activity against the bacterial pathogen *Aeromonas hydrophila* in clown fish (*Amphiprion sebae* and *Amphiprion ocellaris*) (Dhayanithi et al., 2010).

Trials with other fish species have been generally negative. In tilapia (*Oreochromis niloticus*, *Tilapia zillii* and *Oreochromis mossambicus*), neem leaf extract resulted in a typical stress response (hyperglycemia and higher cortisol) (Antache et al., 2014; Oyoo-Okoth et al., 2011). Male and female Nile tilapia showed gonad alterations at levels as low as 0.5 g/l (Jegede et al., 2008a). Histological examination of interstitial tissues of the ovaries in Nile tilapia females showed mild to severe necrosis, increasing with the concentration of neem leaf extract (Obaroh et al., 2014). Only one experiment reported Nile tilapia to have increased lysozyme activity, which is a welfare indicator (Antache et al., 2014). In African catfish (*Clarias gariepinus*), the typical stress response of hyperglycemia was reported after the use of sublethal doses of neem leaf extract over 12 weeks. Fish had histological lesions in gills and liver and lost weight (Ufodike et al., 2007).

#### As biocontrol agent against fish pests and predators

The deleterious effects of neem leaf extract can be used to control undesirable fish species (predators or parasites) in ponds. In tropical freshwater *Prochilodus lineatus* juveniles the LC<sub>50</sub> was set at 4.8 g/l after 72h exposure but deleterious effects including stress response were reported. Damaged gill and kidney tissues were also observed at only 2.5 g/l (Winkaler et al., 2007). In common carp, the LC<sub>50</sub> was reported to be only 0.1 g/l after 24h exposure and as low as 0.05 g/l after 96h exposure (Davoodi, 2012; Ahmad et al., 2011). Alcohol and water-extracted seed kernel and oil could be used to control fish predators (i.e. *Heteropneustes fossilis* and *Anabas testudineus*) (Nasiruddin et al., 1997).

## Crustaceans

Neem leaf extract was reported to have antimicrobial activity against the bacterial pathogen *Aeromonas hydrophila* in prawns (*Macrobrachium malcolmsonii*) (Behera et al., 2004).

## Datasheet citation

Heuzé V., Tran G., Archimède H., Bastianelli D., Lebas F., 2015. *Neem (Azadirachta indica)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/182> Last updated on October 2, 2015, 15:40

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

## Image credits

● Forest & Kim Starr ● Tu7uh ● CostaPPPR ● Mokie ● Qniemiec

 Share / Save   



## Neem (Azadirachta indica)

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

### Tables of chemical composition and nutritional value

- [Neem \(Azadirachta indica\), leaves, fresh](#)
- [Neem \(Azadirachta indica\) seed cake](#)
- [Neem \(Azadirachta indica\) seed kernel cake](#)

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

#### Neem (Azadirachta indica), leaves, fresh



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	33.5	3.9	27.1	37.0	5
Crude protein	% DM	16.6	2.4	12.2	20.4	13
Crude fibre	% DM	16.8	3.5	12.7	21.1	8
NDF	% DM	40.3	9.6	25.5	54.6	7
ADF	% DM	30.0	8.7	20.8	44.8	7
Lignin	% DM	12.3	2.4	9.6	14.5	4
Ether extract	% DM	3.7	0.6	2.6	4.5	9
Ash	% DM	12.0	6.4	5.1	33.3	14
Gross energy	MJ/kg DM	17.6				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	18.3	6.2	13.1	26.5	4
Phosphorus	g/kg DM	2.5	0.7	1.7	3.4	4
Magnesium	g/kg DM	3.1				1
Zinc	mg/kg DM	114				1
Copper	mg/kg DM	13				1
Iron	mg/kg DM	1012				1

Secondary metabolites	Unit	Avg	SD	Min	Max	Nb
Tannins (eq. tannic acid)	g/kg DM	5.0		0.0	10.0	2
Tannins, condensed (eq. catechin)	g/kg DM	6.0				1

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, ruminants	%	58.3				1
Energy digestibility, ruminants	%	57.3				*
DE ruminants	MJ/kg DM	10.1				*
ME ruminants	MJ/kg DM	8.1				*
Nitrogen digestibility, ruminants	%	52.0				1

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

#### References

Amanullah et al., 2006; Babayemi et al., 2006; CIRAD, 1991; Dey et al., 2006; Gowda et al., 2004; Khanum et al., 2007; Majumder et al., 1956; Malik et al., 1967; Sen, 1938

Last updated on 17/02/2015 16:47:50

#### Neem (Azadirachta indica) seed cake

Cake from undecorticated seeds, includes all types of oil extraction



Main analysis	Unit	Avg	SD	Min	Max	Nb
Crude protein	% DM	16.7	3.3	12.4	20.9	7
Crude fibre	% DM	24.3	4.7	17.9	30.1	6

#### 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

Ether extract	% DM	5.5	5.3	0.4	14.8	6
Ash	% DM	12.4	4.0	5.5	16.6	7
Gross energy	MJ/kg DM	18.2				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	7.3	4.8	1.4	16.5	7
Phosphorus	g/kg DM	5.4	2.8	1.6	9.4	7
Magnesium	g/kg DM	4.2				1
Zinc	mg/kg DM	219				1
Copper	mg/kg DM	31				1
Iron	mg/kg DM	244				1

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

#### References

Gowda et al., 2000; Gowda et al., 2004; Krishna, 1985

Last updated on 17/02/2015 16:51:32

### Neem (Azadirachta indica) seed kernel cake

Includes all processed cakes and all types of oil extraction



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	95.4				1
Crude protein	% DM	37.3	2.8	33.0	40.9	19
Crude fibre	% DM	13.8	1.6	11.4	16.8	18
NDF	% DM	36.9				1
ADF	% DM	26.5				1
Ether extract	% DM	6.3	2.9	0.7	10.6	19
Ash	% DM	15.0	3.1	5.6	19.9	19
Starch (polarimetry)	% DM	1.2				1
Total sugars	% DM	10.1				1
Gross energy	MJ/kg DM	18.7				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	8.8	1.3	7.4	11.2	9
Phosphorus	g/kg DM	7.2	2.4	4.5	11.1	9

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

#### References

Djenontin et al., 2012; Elangovan et al., 2000; Gowda et al., 1998; Gowda et al., 2000; Musalia et al., 2000; Nagalakshmi et al., 1999; Nath et al., 1989; Verma et al., 1995

Last updated on 17/02/2015 16:53:06

### Datasheet citation

Heuzé V., Tran G., Archimède H., Bastianelli D., Lebas F., 2015. *Neem (Azadirachta indica)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/182> Last updated on October 2, 2015, 15:40

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

### Image credits

- Forest & Kim Starr
- Tu7uh
- CostaPPPR
- Mokie
- Qniemiec

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



## Neem (Azadirachta indica)

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

### Tables of chemical composition and nutritional value

- [Neem \(Azadirachta indica\), leaves, fresh](#)
- [Neem \(Azadirachta indica\) seed cake](#)
- [Neem \(Azadirachta indica\) seed kernel cake](#)

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

#### Neem (Azadirachta indica), leaves, fresh



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	33.5	3.9	27.1	37.0	5
Crude protein	% DM	16.6	2.4	12.2	20.4	13
Crude fibre	% DM	16.8	3.5	12.7	21.1	8
NDF	% DM	40.3	9.6	25.5	54.6	7
ADF	% DM	30.0	8.7	20.8	44.8	7
Lignin	% DM	12.3	2.4	9.6	14.5	4
Ether extract	% DM	3.7	0.6	2.6	4.5	9
Ash	% DM	12.0	6.4	5.1	33.3	14
Gross energy	MJ/kg DM	17.6				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	18.3	6.2	13.1	26.5	4
Phosphorus	g/kg DM	2.5	0.7	1.7	3.4	4
Magnesium	g/kg DM	3.1				1
Zinc	mg/kg DM	114				1
Copper	mg/kg DM	13				1
Iron	mg/kg DM	1012				1

Secondary metabolites	Unit	Avg	SD	Min	Max	Nb
Tannins (eq. tannic acid)	g/kg DM	5.0		0.0	10.0	2
Tannins, condensed (eq. catechin)	g/kg DM	6.0				1

Ruminant nutritive values	Unit	Avg	SD	Min	Max	Nb
OM digestibility, ruminants	%	58.3				1
Energy digestibility, ruminants	%	57.3				*
DE ruminants	MJ/kg DM	10.1				*
ME ruminants	MJ/kg DM	8.1				*
Nitrogen digestibility, ruminants	%	52.0				1

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

#### References

Amanullah et al., 2006; Babayemi et al., 2006; CIRAD, 1991; Dey et al., 2006; Gowda et al., 2004; Khanum et al., 2007; Majumder et al., 1956; Malik et al., 1967; Sen, 1938

Last updated on 17/02/2015 16:47:50

#### Neem (Azadirachta indica) seed cake

Cake from undecorticated seeds, includes all types of oil extraction



Main analysis	Unit	Avg	SD	Min	Max	Nb
Crude protein	% DM	16.7	3.3	12.4	20.9	7
Crude fibre	% DM	24.3	4.7	17.9	30.1	6

#### 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

Ether extract	% DM	5.5	5.3	0.4	14.8	6
Ash	% DM	12.4	4.0	5.5	16.6	7
Gross energy	MJ/kg DM	18.2				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	7.3	4.8	1.4	16.5	7
Phosphorus	g/kg DM	5.4	2.8	1.6	9.4	7
Magnesium	g/kg DM	4.2				1
Zinc	mg/kg DM	219				1
Copper	mg/kg DM	31				1
Iron	mg/kg DM	244				1

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

#### References

Gowda et al., 2000; Gowda et al., 2004; Krishna, 1985

Last updated on 17/02/2015 16:51:32

### Neem (*Azadirachta indica*) seed kernel cake

Includes all processed cakes and all types of oil extraction



Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as fed	95.4				1
Crude protein	% DM	37.3	2.8	33.0	40.9	19
Crude fibre	% DM	13.8	1.6	11.4	16.8	18
NDF	% DM	36.9				1
ADF	% DM	26.5				1
Ether extract	% DM	6.3	2.9	0.7	10.6	19
Ash	% DM	15.0	3.1	5.6	19.9	19
Starch (polarimetry)	% DM	1.2				1
Total sugars	% DM	10.1				1
Gross energy	MJ/kg DM	18.7				*

Minerals	Unit	Avg	SD	Min	Max	Nb
Calcium	g/kg DM	8.8	1.3	7.4	11.2	9
Phosphorus	g/kg DM	7.2	2.4	4.5	11.1	9

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

#### References

Djenontin et al., 2012; Elangovan et al., 2000; Gowda et al., 1998; Gowda et al., 2000; Musalia et al., 2000; Nagalakshmi et al., 1999; Nath et al., 1989; Verma et al., 1995

Last updated on 17/02/2015 16:53:06

### Datasheet citation

Heuzé V., Tran G., Archimède H., Bastianelli D., Lebas F., 2015. *Neem (Azadirachta indica)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/182> Last updated on October 2, 2015, 15:40

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

### Image credits

- Forest & Kim Starr
- Tu7uh
- CostaPPPR
- Mokie
- Qniemiec

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



## Neem (*Azadirachta indica*)

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

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

### References

- Abbeddou, S. ; Makkar, H. P. S., 2012. Potential and constraints in utilizing co-products of the non-edible oils-based biodiesel industry – an overview : chapter 19. In: Makkar, H. P. S. Biofuel co-products as livestock feeds. Opportunities and challenges, FAO
- Agrawal, D. K. ; Garg, A. K. ; Nath, K., 1987. The use of water washed neem (*Azadirachta indica*) kernel cake in the feeding of buffalo calves. *J. Agric. Sci.*, 108 (2): 497-499
- Ahmad, M. K. ; Ansari, B. A., 2011. Toxicity of neem based pesticide Azacel to the embryo and fingerlings of zebrafish *Danio rerio* (Cyprinidae). *World J. Zool.*, 6 (1): 47-51
- Ahmed, S. ; Idris, S., 1997. *Azadirachta indica* A.H.L. Juss. Record from Proseabase. Faridah Hanum, I ; van der Maesen, L. J. G. (Eds). PROSEA (Plant Resources of South-East Asia) Foundation, Bogor, Indonesia
- Al-Quraishy, S. ; Abdel-Ghaffar, F. ; Al-Rasheid, K. A. S. ; Mehlhorn, J. ; Mehlhorn, H., 2010. Effects of a neem seed extract (MiteStop®) on mallophages (featherlings) of chicken: *in vivo* and *in vitro* studies. *Parasitol. Res.*, 110 (2): 617-622
- Ali, B. H. ; Salih, A. M. M., 1982. Suspected *Azadirachta indica* toxicity in a sheep. *Vet. Rec.*, 111 (21): 494
- Ali, B. H., 1987. The toxicity of *Azadirachta indica* leaves in goats and guinea pigs. *Vet. Human Toxicol.*, 29 (1): 16-19
- Amanullah, M. M. ; Somasundaram, E. ; Alagesan, A. ; Vaiyapuri, K. ; Pazhanivelan, S. ; Sathyamoorthi, K., 2006. Evaluation of some tree species for leaf fodder in Tamil Nadu. *Res. J. Agric. Biol. Sci.*, 2 (6): 552-553
- Anandan, S. ; Sastry, V. R. B. ; Katiyar, R. C. ; Agrawal, D. K., 1999. Processed neem kernel meal as a substitute for peanut meal protein in growing goat diets. *Small Rum. Res.*, 32 (2): 125-128
- Anon., 1976. Neem cake promotional scheme. Khadi and Village Industries Commission. Shivajinagar
- Antache, A. ; Cristea, V. ; Grecu, I. ; Dediu, L. ; Cretu, M. ; Bocioc, E. ; Petrea, S. M., 2014. Effects of dietary supplementation at Nile tilapia with *Thymus vulgaris*, *Trigonella foenum graecum* and *Azadirachta indica* on welfare status. *Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca, Anim. Sci. Biotech.*, 71 (2): 115-122
- Aruwayo, A. ; Maigandi A., 2013. Neem (*Azadirachta indica*) seed cake/kernel as protein source in ruminants feed. *Am. J. Exp. Agric.*, 3 (3): 482-494
- Bais, B. ; Purohit, G. R. ; Dhuria, R. K. ; Pannu, U., 2002. Nutritive value of sares and neem leaves in Marwari goats. *Indian J. Anim. Nutr.*, 19 (3): 266-268
- Bawa, G. S. ; Orunmuyi, M. ; Agbaji, A. S. ; Ladan, Z. ; Okekeifi, U. O., 2007. Effect of different methods of processing neem (*Azadirachta indica*) seeds on performance of young rabbits. *Pakistan J. Nutr.*, 6 (3): 212-216
- Bedi, S. P. S. ; Vijjan, V. K. ; Ranjhan, S. K., 1975. Effect of neem (*Azadirachta indica*) seed cake on growth and digestibility of nutrients in cross-bred calves. *Indian J. Anim. Sci.*, 45 (9): 618-621
- Bedi, S. P. S. ; Vijjan, V. K. ; Ranjhan, S. K., 1975. Utilization of neem (*Azadirachta indica*) seed cake and its influence on nutrients digestibility in buffaloes. *Indian J. Dairy Sci.*, 28: 104
- Behera, S. ; Patel, G. N. ; Rath, R. K. ; Dey, R. K. ; Chand, B. K., 2004. Use of neem leaf extract in controlling bacterial shell disease in *Macrobrachium malcolmsonii* (H.Milne Edward). *Indian J. Anim. Health*, 43 (1): 61-66
- Biswas, K. ; Chattopadhyay, I. ; Banerjee, R. K. ; Bandyopadhyay, U., 2002. Biological activities and medicinal properties of neem (*Azadirachta indica*). *Current Sci.*, 82 (11): 1336-1345
- Biu, A. A. ; Yusufu, S. D. ; Rabo, J. S., 2010. Acute toxicity study on neem (*Azadirachta indica*, Juss.) leaf aqueous extract in chicken (*Gallus gallus domesticus*). *African Scientist*, 11 (4): 241-244
- Boeke, S. J. ; Boersma, M. G. ; Alink, G. M. ; van Loon, J. A. A. ; van Huis, A. ; Dicke, M. ; Rietjens, I. M. C. M., 2004. Safety evaluation of neem (*Azadirachta indica*) derived pesticides. *J. Ethnopharm.*, 94 (1): 25-41
- BOSTID, 1992. *Neem: A Tree for Solving Global Problems*. Rep. Board Sci. Technol. Int. Dev. (BOSTID), National Research Council; Nat. Academies Press, Washington D. C.
- Christopher, J., 1970. Neem-seed cake is also good for cattle. *Indian Farming*, 20: 38
- Davoodi, R., 2012. A 72-hr median lethal concentration (MLC) of neem for *Cyprinus carpio* Linn. (Cyprinidae) juvenile. *Br. J. Applied Sci. Technol.*, 2 (2): 173-178
- Dhayaniithi, N. B. ; Kumar, T. T. A. ; Kathiresan, K., 2010. Effect of neem extract against the bacteria isolated from marine fish. *J. Env. Biol.*, 31 (4): 409-412
- Djenontin, T. S. ; Wotto, W. D. ; Avlessi, F. ; Lozano, P. ; Sohounhloué, D. K. C. ; Pioch, D., 2012. Composition of *Azadirachta indica* and *Carapa procera* (Meliaceae) seed oils and cakes obtained after oil extraction. *Industrial Crops and Products*, 38: 39-45
- Dutta, N. ; Panda, A. K. ; Kamra, D. N., 2012. Use of *Pongamia glabra* (karanj) and *Azadirachta indica* (neem) seed cakes for feeding livestock. In: Makkar, H.P.S, Biofuel co-products as livestock feed - opportunities and challenges, FAO, 379-402
- Elangovan, A. V. ; Verma, S. V. S. ; Sastry, V. R. B. ; Singh, S. D., 2000. Laying performance of Japanese quail fed graded levels of neem (*Azadirachta indica*) kernel meal incorporated diets. *Anim. Feed Sci. Technol.*, 88 (1-2): 113-120
- Elangovan, A. V. ; Verma, S. V. S. ; Sastry, V. R. B. ; Singh S. D., 2000. Effect of feeding neem (*Azadirachta indica*) kernel meal on growth, nutrient utilization and physiology of Japanese quails (*Coturnix coturnix japonica*). *Asian-Aus. J. Anim. Sci.*, 13 (9): 1272-1277
- Fajinmi, A. O. ; Adedeji, S. K. ; Hassan, W. A. ; Babatunde, G. M., 1990. Inclusion of non-conventional feedstuffs in rabbit concentrate ration - a case study of neem (*Azadirachta indica*) seeds. *J. Appl. Rabbit Res.*, 13 (3-4): 125-126

- FAO, 2015. Grassland Index. A searchable catalogue of grass and forage legumes. FAO, Rome, Italy 
- Gandhi, M. ; Lal, R. ; Sankaranarayanan, A. ; Banerjee, C. K. ; Sharma, P. L., 1988. Acute toxicity study of the oil from *Azadirachta indica* seed (neem oil). *J. Ethnopharma.*, 23 (1): 39-51 
- Gowda, S. K. ; Sastry, V. R. B. ; Katiyar, R. C., 1998. Study on the utilization of neem kernel meal as a protein supplement for growing rabbits. *Indian Vet. J.*, 75 (3): 281-282 
- Göhl, B., 1982. Les aliments du bétail sous les tropiques. FAO, Division de Production et Santé Animale, Roma, Italy 
- Gowda, S. K. ; Sastry, V. R. B. ; Katiyar, R. C., 1998. Study on the utilization of neem kernel meal as a protein supplement for growing rabbits. *Indian Vet. J.*, 75: 281-282
- Gowda, S. K. ; Verma, S. V. S. ; Elangovan, A. V. ; Singh, S. D., 1998. Neem (*Azadirachta indica*) kernel meal in the diet of White Leghorn layers. *Br. Poult. Sci.*, 39 (5): 648-652 
- Gowda, S. K. ; Sastry, V. R. B., 2000. Neem (*Azadirachta indica*) seed cake in animal feeding - Scope and limitations - Review. *Asian-Aus. J. Anim. Sci.*, 13 (5): 720-728 
- Gowda, S. K. ; Sastry, V. R. B. ; Katiyar, R. C., 2000. Nutritional efficacy of New Zealand White rabbits fed processed neem (*Azadirachta indica*) kernel meal as a protein supplement. *Int. J. Anim. Sci.*, 15: 95-98 
- Harikrishnan, R. ; Balasundaram, C. ; Bhuvanewari, R., 2005. Restorative effect of *Azadirachta indica* aqueous leaf extract dip treatment on haematological parameter changes in *Cyprinus carpio* (L.) experimentally infected with *Aphanomyces invadans* fungus. *J. Applied Ichthyol.*, 21 (5): 410-413 
- Hentgen, A., 1985. Forages trees in India, a chance for rearing ruminants. *Fourrages*, 101: 105-119 
- Ibrahim, I. A. ; Khalid, S. A. ; Omer, S. A. ; Adam, S.E.I., 1992. On the toxicology of *Azadirachta indica* toxicosis in chicks. *Vet. Human Toxicol.*, 34 (3): 221-224 
- Ibrahim, L. A., Khalid, S. A., Omer, S. A. ; Adam, S. E. I., 1992. On the toxicology of *Azadirachta indica* leaves. *J. Ethnopharmacol.*, 35 (3): 267-273 
- Jegade, T. ; Fagbenro, O., 2008. Dietary neem (*Azadirachta indica*) leaf meal as reproduction inhibitor in redbelly tilapia, *Tilapia zillii*. In: Elghobashy, H. ; Fitzsimmons, K. ; Diab, A. S. (Eds). From the pharaohs to the future. 8th Int. Symp. on Tilapia in Aquacult Proc., Cairo, Egypt, 12-14 October, 2008 pp: 365-373 
- Jegade, T.; Fagbenro, O., 2008. Histology of gonads in *Tilapia zillii* (Gervais) fed neem (*Azadirachta indica*) leaf meal diets. In: Elghobashy, H. ; Fitzsimmons, K. ; Diab, A. S. (Eds). From the pharaohs to the future. 8th Int. Symp. on Tilapia in Aquacult Proc., Cairo, Egypt, 12-14 October, 2008: 1129-1134 
- Jindal, T. ; Agrawal, N. ; Khanna, S. ; Gupta, M., 2012. Margosa (neem) oil poisoning. *Pediatric Oncall* 9 (6): 34 
- Ketkar, C. M., 1976. Final Technical Report-Utilisation of Neem (*Azadirachta indica* A. Juss) and its by products. Final technical report of Directorate of Non-Edible Oils and Soap Industry, Khadi and Village Industries Commission. Lahshmikanthan, Irla Road, Vile Parle, Bombay 400 056 N.D. Sadhna Press, Pune, India
- Khanum, S. A. ; Yaqoob, T. ; Sadaf, S. ; Hussain, M. ; Jabbar, M. A. ; Hussain, H. N. ; Kausar, R. ; Rehman, S., 2007. Nutritional evaluation of various feedstuffs for livestock production using *in vitro* gas method. *Pakistan Vet. J.*, 27 (3): 129-133 
- Khosla, P. ; Bhanwra, S. ; Singh, J. ; Seth, S. ; Srivastava, R. K., 2000. A study of hypoglycaemic effects of *Azadirachta indica* (Neem) in normal and alloxan diabetic rabbits. *Indian J. Physiol. Pharmacol.*, 44 (1): 69-74 
- Kone, A., 2010. Effects of incorporation of neem (*Azadirachta indica*, A. Juss) oilmeal at low levels in the feed and in the bedding on performance and health of broilers. Ph.D. dissertation, Chiekh Anta Diop University, Dakar, Senegal 
- Kumar, K. P. ; Reddy, C. R. ; Rao, M. R. ; Reddy, T. J. ; Rao, V. P. ; Sastry, V. R. B., 1992. Utilization of water washed neem seed cake as cattle feed. *Indian Vet. J.*, 69 (6): 127-132 
- Landy, N. ; Ghalamkari, G. ; Toghiani, M., 2011. Performance, carcass characteristics, and immunity in broiler chickens fed dietary neem (*Azadirachta indica*) as alternative for an antibiotic growth promoter. *Livest. Sci.*, 142 (1-3): 305-309 
- Lebas, F., 2013. Estimation de la digestibilité des protéines et de la teneur en énergie digestible des matières premières pour le lapin, avec un système d'équations. 15ème Journées de la Recherche Cunicole, Le Mans, 19-20 novembre 2013 
- Lenka, S. ; Giri, S. S. ; Paul, B. N., 2010. Nutrient digestibility and gastro-intestinal enzyme activity of *Cyprinus carpio* (var. *communis*) fingerlings fed water washed neem seed cake incorporated diets. *Indian J. Anim. Sci.*, 80 (5): 486 
- Lusweti, A. ; Wabuyele, E. ; Ssegawa, P. ; Mauremootoo, J., 2011. *Azadirachta indica* (Neem). BioNET-EAFRINET UVIMA Project 
- Majumder, S. G. ; Dutta, R. N. ; Ganguli, N. C., 1956. Amino acid composition of some Indian vegetables as determined by paper chromatography. *Fd. Res.*, 21: 477-480 
- Malik, M. Y. ; Sheik, A. A. ; Shah, W. A., 1967. Chemical composition of indigenous fodder tree leaves. *Pakistan J. Sci.*, 19 (4): 171-174 
- Mandal, N., 1997. Nutritive values of tree leaves of some tropical species for goats. *Small Rumin. Res.*, 24 (2): 95-105 
- Mohan, J. ; Praveen, K. T. ; Pramod, K. T. ; Verma, S. V. S. ; Moudgal, R. P., 1997. Antifertility effect of neem (*Azadirachta indica*) seed kernel meal in chickens. *Asian-Aus. J. Anim. Sci.*, 10 (6): 609-613 
- Musalial, L. M. ; Anandan, S. ; Sastry, V. R. B. ; Agrawal, D. K., 2000. Urea-treated neem (*Azadirachta indica* A. juss) seed kernel cake as a protein supplement for lambs. *Small Rumin. Res.* 35 (2): 107-116 
- Nagalakshmi, D. ; Sastry, V. R. B. ; Agrawal, D. K. ; Katiyar, R. C. ; Verma, S. V. S., 1996. Performance of broiler chicks fed on alkali treated neem (*Azadirachta indica*) kernel cake as a protein supplement. *Br. Poult. Sci.*, 37 (4): 809-818 
- Nagalakshmi, D. ; Sastry, V. R. B. ; Katiyar, R. C. ; Agrawal, D. K. ; Verma, S. V. S., 1999. Performance of broiler chicks fed on diets containing urea ammoniated neem (*Azadirachta indica*) kernel cake. *Br. Poult. Sci.*, 40 (1): 77-83 
- Nasiruddin, M. ; Azadi, M. A. ; Chowdhury, R. ; Majumder, S. M. M. H., 1997. Piscicidal effect of seed kernel extracts and oil of seed kernels of *Azadirachta indica* A. Juss on two predatory fishes *Heteropneustes fossilis* (Bloch) and *Anabas testudineus* (Bloch).. *Chittagong Univ. Studies, Sci.*, 21 (1): 53-62 
- Nath, K. ; Rajagopal, S. ; Garg, A. K., 1983. Water-washed neem (*Azadirachta indica* Juss) seed kernel cake as a cattle feed. *J. Agric. Sci.*, 101 (2): 323-326 
- Nath, K. ; Agrawal, D. K. ; Hassan, Q. Z. ; Danial, S. J., 1989. Water-washed neem (*Azadirachta indica*) seed kernel cake in the feeding of milch cows. *Anim. Prod.*, 48 (3): 497-502 
- Obaroh, I. O. ; Nzeh, G. C., 2014. Histological changes in gonads and liver of *Oreochromis niloticus* (L.) fed crude extract of *Azadirachta indica* leaf. *Int. J. Biochem. Res. Review*, 4 (5): 420-429 

- Ogbuwu, I. P. ; Uchegbu, M. C. ; Okoli, I. C. ; Iloeje, M. U., 2010. Assessment of blood chemistry, weight gain and linear body measurements of pre-puberal buck rabbits fed different levels of neem (*Azadirachta indica* a. Juss.) leaf meals. *Chilean J. Agric. Res.*, 70 (3): 515-520
- Ogbuwu, I. P. ; Uchegbu, M. C. ; Okoli, I. C. ; Iloeje, M. U., 2010. Toxicological effects of leaf meal of ethnomedicinal plant - neem - on serum biochemistry of crossbred New Zealand white typed rabbit bucks. *Report and Opinion*, 2 (2): 54-57
- Ogbuwu, I. P. ; Okoli, C. I. ; Iloeje, M. U., 2011. Evaluation of leaf meal of an ethnomedicinal plant-neem-on linear growths and reproductive tract morphometry of rabbit does. *African J. Biomed. Res.*, 13 (3): 207-212
- Ogbuwu, I. P., 2008. Physiological responses of rabbits fed graded levels of neem (*Azadirachta indica*) leaf meal. Thesis, University of Technology, Owerri, Nigeria, 200 pp.
- Orwa, C.; Mutua, A.; Kindt, R.; Jamnadass, R.; Anthony, S., 2009. *Agroforestry Database: a tree reference and selection guide version 4.0*. World Agroforestry Centre, Kenya
- Oyoo-Okoth, E. ; Ngugi, C. C. ; Chepkirui-Boit, V., 2011. Physiological and biochemical responses of Nile tilapia (*Oreochromis niloticus*) exposed to aqueous extracts of neem (*Azadirachta indica*). *J. Appl. Aquacult.*, 23 (2): 177-186
- Patel, B. M. ; Patel, P. S., 1957. Fodder value of tree and vegetable leaves in Kaira District. *Indian J. Agric. Sci.*, 27: 307-315
- Puri, H. S., 1999. *Neem: the divine tree (Azadirachta indica)*. Harwood Academic Publishers
- Raghuvansi, S. K. S. ; Prasad, R. ; Mishra, A. S. ; Chaturvedi, O. H. ; Tripathi, M. K. ; Misra, A. K. ; Saraswat, B. L. ; Jakhmola, R. C., 2007. Effect of inclusion of tree leaves in feed on nutrient utilization and rumen fermentation in sheep. *Biores. Technol.*, 98 (3): 511-517
- Raghuvansi, S. K. S. ; Tripathi, M. K. ; Mishra, A. S. ; Chaturvedi, O. H. ; Prasad, R. ; Saraswat, B. L. ; Jakhmola, R. C., 2007. Feed digestion, rumen fermentation and blood biochemical constituents in Malpura rams fed a complete feed-block diet with the inclusion of tree leaves. *Small Rumin. Res.*, 71 (1-3): 21-30
- Ramachandran, S. ; Singh, S. K. ; Larroche, C. ; Soccol, C. R. ; Pandey, A., 2007. Oil cakes and their biotechnological applications – A review. *Biores. Technol.*, 98 (10): 2000-2009
- Ramu, A. ; Reddy, T. J. ; Raghavan, G. V. , 1994. Effect of feeding complete feeds containing water washed neem seed cake on nutrient utilization in sheep and goats. In: Djajanegara, A.; Sukmawati, A. (Eds.), *Sustainable Anim. Prod. Environ., Proc. 7th AAAP Anim. Sci. Congress, Bali, Indonesia, 11-16 July, 1994*
- Ranjhan, S. K., 1980. *Animal nutrition and feeding practice in india*. Vikas Publishing House, New Delhi, 350 p.
- Rao, P.U., 1987. Chemical composition and biological evaluation of debitterized and defatted neem (*Azadirachta indica*) seed kernel cake. *J. Am. Oil Chem. Soc.*, 64 (9): 1348-1351
- Reddy, V. R. ; Rao, P. V. ; Reddy, C. V., 1988. Chemical composition and nutritive value of processed neem cake. *Indian J. Anim. Sci.*, 68: 870-873
- Reddy, K. C. V., 1992. Performance of buffalo calves fed alkali-treated and urea-ammoniated neem seed kernel cake incorporated rations. MSc. Thesis. IVRI, Izatnagar, India
- Rojas-Sandoval, J. ; Acevedo-Rodriguez, P. , 2014. *Azadirachta indica* (neem tree). *Invasive Species Compendium*, Wallingford, UK: CAB International
- Rukmini, C., 1987. Chemical and nutritional evaluation of neem oil. *Food Chem.*, 26 (2): 119-124
- Sastry, V. R. B. ; Agrawal, D. K., 1992. Utilization of water washed neem (*Azadirachta indica*) seed kernel cake as a protein source for growing pigs. *J. Appl. Anim. Res.*, 1 (2): 103-107
- Sastry, V. R. B. ; Katiyar, R. C. ; Agrawal, D. K., 1999. Performance of buffalo bull calves fed alkali treated or urea ammoniated neem (*Azadirachta indica*) seed kernel cake as protein supplement. *Indian J. Anim. Sci.*, 69 (12): 1074-1076
- Sen, K. C., 1938. The nutritive values of Indian cattle feeds and the feeding of animals. *Indian Council of Agricultural Research, New Dehli, Bulletin No. 25, 1-30*
- Srisaikhram, S., 2009. Effect of neem (*Azadirachta indica* A. Juss. var. *siamensis* Valetton) foliage utilization in meat goat diets on rumen fermentation and productive performances. PhD Thesis, Technol. Univ. Suranaree, Thailand
- Subapriya, R. ; Nagini, S., 2005. Medicinal properties of neem leaves: a review. *Curr. Med. Chem. Anticancer Agents*, 5 (2):149-
- Suchitra, K. ; Wanapat, M., 2008. Study on ruminal degradability of local plants by using nylon bag technique. *Livest. Res. Rural Dev.*, 20 (Suppl.)
- Sundaravalli, N. ; Bhastkar Raju, B. ; Krishnamoorthy, K. A. , 1982. Neem oil poisoning. *Indian J. Pediatrics*, 49 (3): 357-359
- Talpur, A. D.; Ikhwanuddin, M., 2013. *Azadirachta indica* (neem) leaf dietary effects on the immunity response and disease resistance of Asian seabass, *Lates calcarifer* challenged with *Vibrio harveyi*. *Fish Shellfish Immunol.*, 34 (1): 254-264
- Tilander, Y. ; Bonzi, M., 1997. Water and nutrient conservation through the use of agroforestry mulches, and sorghum yield response. *Plant Soil*, 197 (2): 219-232
- Ufodike, E. B. ; Davut, O. E. ; Arazu, V. N., 2007. Effects of exposure to sublethal concentrations of *Azadirachta Indica* on the fingerlings of *Clarias gariepinus*. *Trop. Freshwater Biol.*, 16 (2): 21-26
- Uko, O. J. ; Kamalu, T. N., 2006. Protein quality and toxicity of full-fat neem (*Azadirachta indica* A. Juss) seed kernel. *Arch. Zootec.*, 55 (209): 51-62
- Uko, O. J. ; Kamalu, T. N., 2008. Trend of feed consumption and efficiency of broiler production with raw or heat-treated neem kernels. *Arch. Zootec.*, 57 (220): 489-496
- Verma, A. K. ; Sastry, V. R. B. ; Agrawal, D. K., 1995. Feeding of water washed neem (*Azadirachta indica*) seed kernel cake to growing goats. *Small Rum. Res.*, 15 (2): 105-111
- Verma, A. K. ; Sastry, V. R. B. ; Agrawal, D. K., 1996. Chevon characteristics of goats fed diets with water washed neem (*Azadirachta indica*) seed kernel cake. *Small Rum. Res.*, 19 (1): 55-61
- Vijjan, V. K., 1983. A note on the removal of growth depressant factor in neem (*Azadirachta indica*) seed cake. *J. Vet. Physiol. Allied Sci.*, 2 (1): 25-28
- Wasanthakumar, P. ; Sharma, K. ; Sastry, V. R. B. ; Kumar, S., 1999. Effect of graded dietary levels of neem (*Azadirachta indica*) seed kernel cake on carcass characteristics of broiler rabbits. *Asian Aust. J. Anim. Sci.*, 12 (8): 1246-1250
- Wasanthakumar, P. ; Sharma, K. ; Sastry, V. R. B. ; Agrawal, D. K., 1999. Effect of replacing peanut meal by neem (*Azadirachta indica*) seed kernel cake on nutrient intake, digestibility and retention, and on body weight of broiler rabbits.

World Rabbit Sci., 7 (3): 145-149

Webb, R., 1988. A preliminary investigation into the fodder qualities of some trees in Sudan. Int. Tree Crops J., 5 (1-2): 9-17

Winkaler, E. U. ; Santos, T. R. M. ; Machado-Neto, J. G. ; Martinez, C. B. R., 2013. Acute lethal and sublethal effects of neem leaf extract on the neotropical freshwater fish *Prochilodus lineatus*. Comp. Biochem. Physiol. Toxicol., Pharmacol., 145 (2): 236-244

Zech, W.; Weinstabel, P. E., 1983. Location, state of nutrition and feed value of tree species important in forestry in Upper Volta. Plant Res. Devel., 17: 42-60

102 references found

## Datasheet citation

Heuzé V., Tran G., Archimède H., Bastianelli D., Lebas F., 2015. *Neem (Azadirachta indica)*. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/182> Last updated on October 2, 2015, 15:40

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

## Image credits

● Forest & Kim Starr ● Tu7uh ● CostaPPPR ● Mokie ● Qniemiec

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

