

Tannin toxicity in herbivores in Namibia



Animals have numerous ways of avoiding predators from eating them, and probably the most important one is to run away. Plants however lack this ability, but a huge number of animals eat plants (herbivores). Although we often not realize it, plants do have several ways of defending themselves against herbivores. Some bushes and trees have physical barriers such as thorns, some grasses are very rough and hard. Other plants have a whole arsenal of chemicals to ward off herbivores. Some are just repelling, others toxic, and some plants can even kill animals!

One of the chemicals that can affect herbivores are tannins. Plants can produce tannins to defend themselves, and when animals keep on eating them, the tannin levels can become sufficient to create a tannin toxicity. In times of drought and/or overgrazing, this can pose a real problem to your herds, as animals are forced to browse on high tannin containing plants. In this article we go deeper into this complex problem.

What are tannins and where do they occur?

The word tannin comes from the old German word 'tanna', which means oak. The word 'tanning' was used to describe the process of transforming animal hides into leather by using tree bark that is high in tannin content. Oak and wattle trees are examples that have been traditionally used for this.

Tannins are a class of astringent (dry, slightly bitter taste) plant molecules that bind to and precipitate¹ proteins, starch, cellulose and minerals. This complex process basically deprives the animal of nutrients, which are then not completely digested and are passed out with the faeces. If you eat unripe pears or plums, or drink very strong tea for example, you can 'taste and feel' the tannins – it tastes bitter and you get a dry, crusty sensation in the mouth. Tannins are common in fruit, leguminous plants (members of the pea family), pod-bearing trees and shrubs (esp. *Acacia* and *Sesbania* species) as well as in some grass species (sorghum, corn).

Plant parts that contain tannin include bark, wood, fruit, fruit pods, leaves, roots and plant galls (bizarre lumps and bumps occurring on plants following the invasion of viruses, fungi, bacteria as well as mites).

How do tannins affect an animal?

Tannins reduce the palatability (being tasty) as well as the digestibility of ingested plant material. This is part of a plants defence mechanism to protect itself from over-utilization by herbivores. When considering the negative effects of tannins on herbivores, we have to differentiate between a true tannin toxicity and digestive inhibition by tannins.

True tannin toxicity in ruminants may occur in animals that are fed oak (*Quercus* spp.) and several tropical tree legumes (e.g., *Terminalia oblongata* and *Clidemia hirta*). Digestion as well as microbial metabolism of the ingested tannins convert these into absorbable toxins. Ingestion may result toxicity and mortality of 20% or more of the animals. When doing a Post-Mortem, the main lesions are haemorrhagic gastroenteritis as well as severe liver and kidney damage. Since these plants do not occur in Namibia, true tannin toxicity is very unlikely here.

¹ cause a substance to be deposited in solid form from a solution

Tannins negatively affect animal's feed intake, feed digestibility, and efficiency of production (= digestive inhibition). These effects vary depending on the concentration, the type of tannin ingested, as well as the animal's tolerance for tannins. The latter is dependent on characteristics such as type of digestive tract, feeding behaviour, body size, and detoxification mechanisms. The tannins can affect the animal in the following ways:

- 🐾 Reduced food intake, caused by the bitter and unpleasant taste of tannins (a defence mechanism to protect plants from over-utilisation). This is especially important during the early phases of plant growth.
- 🐾 Tannins interfere with the digestion by forming non- or poorly digestible complexes with proteins, starch, cellulose, minerals etc. This undigested food accumulates in the rumen/stomach, thereby suppressing the animals' appetite.
- 🐾 Drying reduces the solubility of tannins and, thus their ability to complex proteins etc. As a result, animals can consume larger quantities of tannin rich foods if the latter are in a dried form.

The risk of tannin induced digestive disturbance can be decreased by using a compound with a high affinity for tannins, like PEG (polyethylene glycol), e.g., "Browse Plus". PEG has a higher affinity for tannins than do proteins and other nutrients. They bind the tannins, thus sparing the nutrients for normal digestion which can increase feed palatability as well as digestibility and result in higher productivity. PEG is relatively inexpensive and can be sprayed on the forages or added in the diet.

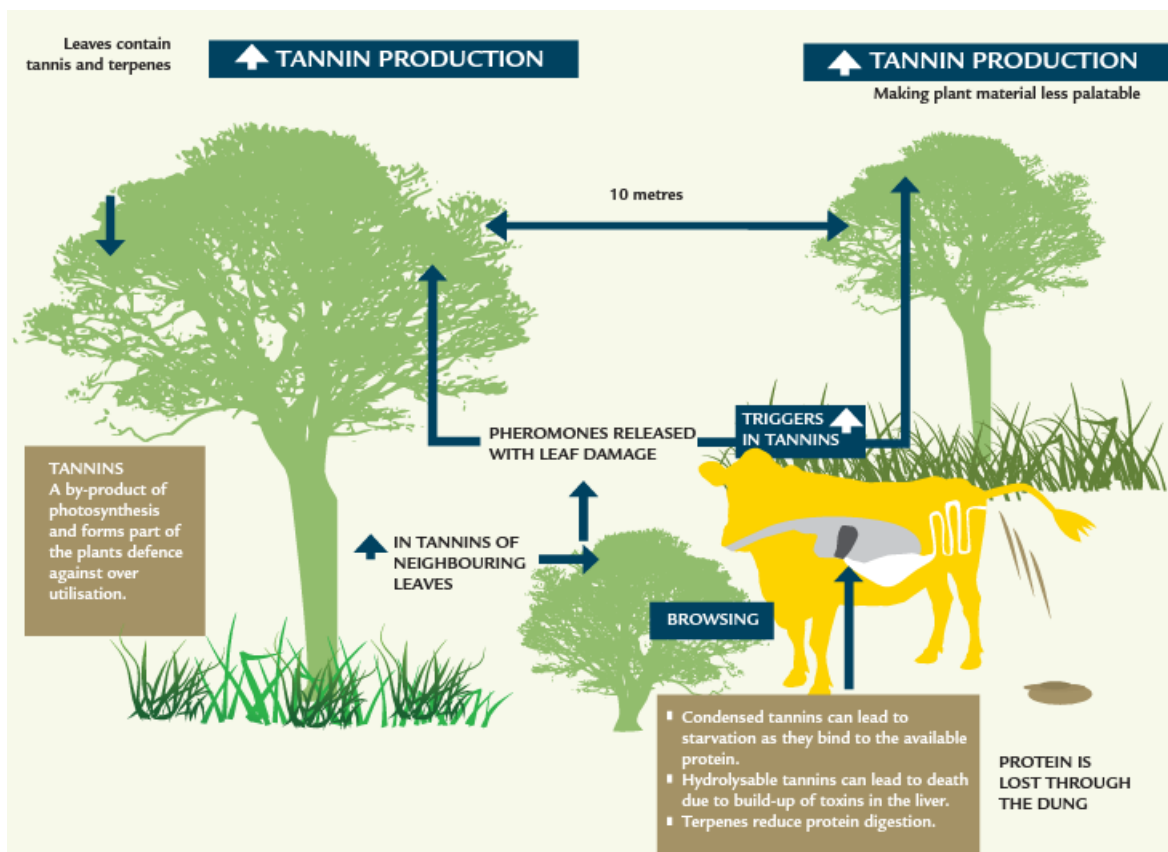




Figure 1 Tannins are a natural product of plants which help to defend them against over grazing/browsing. Tannins cause the plant material to taste unpleasant – animals will move further on to forage. When there is not enough food, animals are forced to eat tannin-rich plants. Tannins will then interfere with the animal's digestion – the animal cannot properly digest nutrients anymore, which are lost via the faeces. Animals starve while having a 'full' belly. © Virbac

Do animals have natural defences against the effects of tannins?

Based on their specific feeding niche, herbivores are subdivided into four groups, with each group consuming different levels of tannins and associated compounds. Animals in these different groups have undergone various physiological adaptations to reduce the activity of plant secondary compounds in their diet.

Table 1 Species specific adaptations in line with their tannin intake

Dietary tannin content	Salivary PRP's	Feeding niche	Examples
LOW 	LOW 	Grazer	Cattle and sheep, oryx, hartebeest, wildebeest
		Mixed feeder	Eland, Impala, springbuck
		Browser	Goat, kudu, giraffe, duiker, black rhino
		Specialized browser	Koala; very dependent on tannin-rich leaves of Eucalyptus trees
HIGH	HIGH		

Many browsers (animals consuming food with higher tannin content) secrete a tannin-binding protein, the so-called salivary proline rich proteins (PRP's) in their saliva. These PRP's inactivate tannins to a greater extent than do dietary proteins. There are species differences in the amount of PRP's produced and their ability to tolerate tannins (see Table 1 Table 1), which is in part genetic (species with well-developed parotid salivary glands e.g. duiker and deer), but likely also adaptive, where consumption of high tannin diets stimulates the development of the salivary glands to increase PRP production. This adaptation seems to be lacking in grazers.

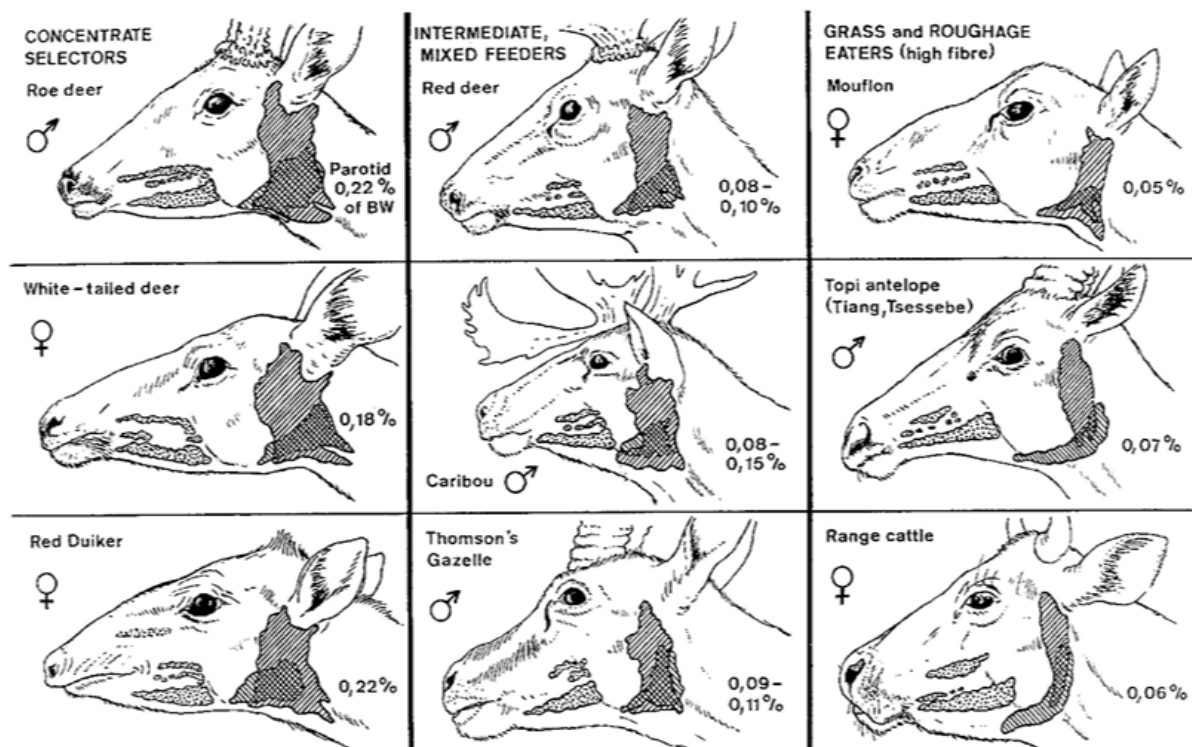


Figure 2 A comparison of the salivary gland anatomy (from left to right: buccal, mandibular, parotid salivary glands) in nine ruminant species based on their feeding niche. Browsers have better developed salivary glands compared to grazers © Hofmann (1988)

Further, the gut structure influences the methods and sites of tannin metabolism. Micro-organisms in the forestomachs of ruminants can modify a broader range of compounds than are mammals. This can be significant in determining the fate of tannins in digestion and the risk of toxicity. However, **it can take several months of exposure to secondary compounds before gut microbes adapt sufficiently to utilizing them.** This is time that is not available to animals exposed to high tannin containing plants during a food availability bottle-neck, when a very significant percentage of food ingested is very high in tannin content!

When are our animals at greatest risk of 'tannin toxicity'?

Under normal circumstances, browsers will usually browse leaves from a tree or bush for a few minutes, and then move onto the next, and then the next. With plenty of browse available, they cause only minimal “damage” to individual plants, while spending most of their day wandering from bush to bush.

Under feeding stress, when there aren't enough trees and bushes to go around, animals are forced to over-browse from the same tree. This activates the trees' defence mechanism and increases tannin production. Browsers are thus very susceptible to changes in their environment:

- 🐾 In areas of excessive debushing
- 🐾 Too many browsers in a contained environment (small farm or breeding camp)
- 🐾 Drought and fire damage

Table 2 Tannin increases in three tree species in response to the effects of simulated browsing damage. The tannin levels were elevated for 100 hours before they began to decline.

Species	% Rise in tannin after 15 min	% Rise in tannin after 60 min
<i>Peltophorum africanum</i> (Weeping wattle)	44	256
<i>Rhus leptodictya</i> (Mountain karee)	76	275
<i>Acacia caffra</i> (Hook thorn)	94	282

Case examples of current situation with kudu and giraffe

On quite a few farms we visited in September/October 2023 we noticed that the kudus are in very poor condition in spite of seemingly having a full belly. These kudus are spending much of their time feeding from trees and bushes with a very clearly visible browse line. This picture is especially common on farms with a high kudu density in combination with many impalas and springbuck competing for the same food.

The browse line gives a very clear indication of over-browsing which will result in increased tannin secretion, reduced food digestibility and animals literally starving with a “full belly” as is demonstrated by the photos.



Figure 3 From left to right: a kudu cow in poor condition, but with a ‘full’ belly. On the second photo you see a Vachellia (Acacia) tree in bloom displaying a very clear browse line, while the tree in the third photo only has leaves on the inside of the bush. These are clear signs of over-browsing. © M. Bijsterbosch

5

In our [January 2022 newsletter](#), we have published an article about food deficiency and mortality in especially young giraffe. In October 2023 we have been contacted by three different farmers having lost young giraffe due to starvation. This is essentially the same problem as noted in kudu.



Figure 4 These photos show what over-browsing by giraffes can do. On the 1st photo you see a Camelthorn tree (Vachellia erioloba) along the highway, where no giraffes are present. The other 2 photos show Shepherd's trees (Witgat - Boscia albitrunca) which are heavily browsed by giraffes. You can clearly see the browse line, and there is no way a young giraffe can reach the leaves. © U. Tubbesing

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How can we minimize the risk of tannin toxicity?

As a farmer, there are a few things you can do to minimize the risk of tannin toxicity amongst your animals:

- 🐾 Avoid overgrazing, and especially over-browsing, by keeping animal numbers within the species-specific stocking capacity of a camp or farm. A heavily de-bushed camp should not be stocked with kudu and giraffe!
- 🐾 Avoid small breeding camps for browsers. In one study it was estimated that a single kudu needs around 1500 bushes of browsing height to survive. Needless to say, it will be rather difficult to keep 20 or more kudus in a 100-ha breeding camp.
- 🐾 Provide Polyethylene Glycol, better known as “[Browse Plus](#)” from Virbac in drinking water, or as feed/lick additive. Clinical trials as well as field experience by many farmers who have used this product for many years provide ample proof of its efficiency. It is critical that this product is NOT a license to overstock! Farmers are ultimately responsible for their management actions and will bear their fruit (good or bad)!
 - Browse Plus is a specialised formula designed as an additive to drinking water, feed or lick. It largely counteracts the effects of tannins and thus enhances the animal’s digestive process, resulting in better nutrient utilisation.
 - Follow [this link](#) to the Browse Plus Product Leaflet, which gives you more information on how this product works, and how you should use it.

If you are interested in reading more about nutrition, we have several articles available on our website:

- 🐾 [Feeding wildlife during drought](#) – how to manage your animal population during a drought.
- 🐾 [Change, the driver of feeding behaviour in \(wild\) animals](#) – how are feeding behaviour and food selection amongst animals influenced.
- 🐾 [Body condition score in antelopes](#) – how to assess body condition in antelopes and how to improve the body condition.