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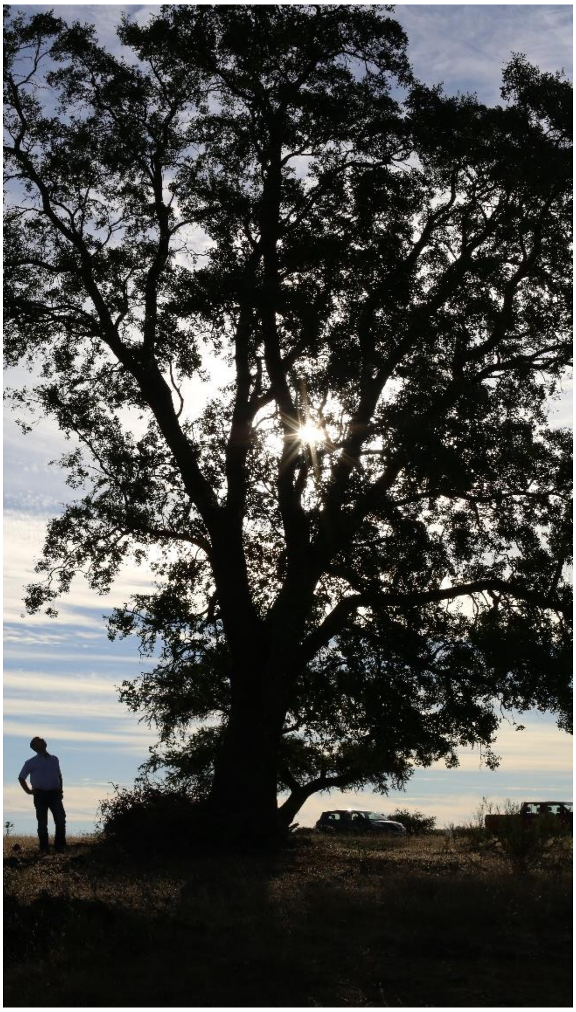
Phytogenic ingredients in the spotlight:

Quillaja - A big tree with a big impact



Do you know that Quillaja is already a part of your daily life? Might be surprising to you, as this plant-based ingredient is not as well-known in comparison to herbs and spices used in kitchens worldwide. Even when going deeper into the phytogenic conversation - **the group of saponins, where Quillaja belongs to**, often stands in the shadows of other substance groups like essential oils. Quite inexplicable, when having a closer look at Quillaja's broad spectrum of efficacy for humans and animals. A good reason to bring this important substance out of the dark.

Therefore, we will take you on a journey. Our destination? **Chile, Latin America - the place where the up to 30 meters high and 100 years old Quillaja trees are native.** The power of the phytogenic universe is tremendous, but often natural resources are limited. This is also the case with Quillaja trees. They only occur naturally in the wild and can hardly be cultured. Therefore, the forestry process is strictly regulated to be sustainable: The Chilean government gives out individual licenses to harvesters to ensure that only a certain number of trees will be cut down and processed. Usually only branches of trees are cut, not the entire tree. What else do you need to know to become a Quillaja expert?

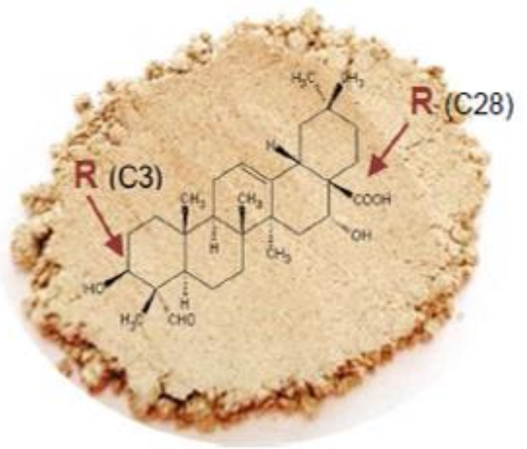
Quillaja saponaria in portrait

Quillaja saponaria Molina, also known as the soap bark tree, is a hardwood tree and the only genus within the family of Quillajaceae belonging to the order of Fabales. It is an evergreen tree with white flowers and a dry fruit, solely inhabiting arid areas of South America. Active substances are mainly extracted out of the plant's bark (but also the wood is used) by boiling Quillaja chips and subsequent evaporation to increase the concentration.

The word **"quillay"** is derived from the native Mapuche word "quillean" and **means "to wash" – a strong reference to the distinctive foaming charactericstics of saponins**. Therefore, Quillaja has been used since ancient times as soap, detergent and in traditional medicines to relieve cough and bronchitis[1]. In human food, Quillaja is widely used for example in water-based non-alcoholic drinks like soda, sport and electrolyte drinks, in candies and in cosmetics like lipsticks and shampoos.

Getting a better understanding of the various effects and applications of Quillaja, it needs a closer look at the chemical structure and the mode of action. Curious what impressive details will be further unveiled?

Active substances



Quillaja is a very **complex natural saponin source containing more than 600 different saponin types.** The chemical structure of Quillaja saponins consists of a hydrophilic oligosaccharide moiety glycosidically linked to a triterpenoid hydrophobic aglycone (sapogenin) (Figure 1).

Besides their high content of triterpenoid saponins, Quillaja extracts contain a unique polyphenol profile. The major phenolic compound was identified as (+)-piscidic acid, which contributes to the **antimicrobial effects of Quillaja saponins.**[2]

Figure 1: Quillaic acid. Backbone of triterpenoid saponins from *Quillaja saponaria* Molina.

Quillaja vs. Yucca saponins

Yucca schidigera (Mexico) and *Quillaja saponaria* (Chile) are both desert plants used as commercial sources for saponins. Saponins from both plants contain one or more water-soluble carbohydrate side chains, while they differ in the aglycone part, the lipophilic nucleus of the saponins. This nucleus has a **steroid structure in Yucca and a triterpenoid structure in Quillaja**. Overall, Quillaja saponins are more complex in structure than Yucca saponins.

One of the main use of **Quillaja saponin extracts in animals is its application as an adjuvant in veterinary vaccines.** Due to the saponin structure, Quillaja saponins exert unique immune modulatory effects, increasing the efficacy of the vaccines.[3]

For their use as feed additives, studies comparing Quillaja and Yucca saponins were mainly done for ruminant systems, both *in vitro* and *in vivo*. Both saponin sources have been proven to decrease *in vitro* ammonia production, protozoa numbers[4] and methane production.[5] In the literature, the effect of these saponins on protozoa is one key argument in their mechanism to achieve observed ammonia reductions. It was found in Delacon *in vitro* studies together with the French research institute INRA that Quillaja is also able to reduce ammonia production without reducing protozoal numbers, suggesting differences in the mode of action compared to Yucca extracts. *In vitro* results also suggest, that Quillaja has more impact on volatile fatty acids, especially in terms of propionate production, in rumen simulation techniques than Yucca.[4, 6]

In vivo studies comparing both saponin sources are scarce, but it was shown that reduction of ammonia is also found in sheep, although no effects on rumen protozoa were observed.[7] In that study, Quillaja supplementation increased digestible energy of the diets. Moreover, in a broiler trial Delacon confirmed such results on ammonia reduction, with Quillaja, Yucca and blends of both Quillaja and Yucca. The highest efficacy was achieved, when blends contained 50% or more Quillaja.

Therefore, although many effects that were observed for Quillaja and Yucca are similar, the mechanisms responsible for the effects appear to differ at least for some parameters.

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Figure 2: *Quillaja saponaria (left) vs. Yucca schigidera (right)*

Mode of action: Beneficial effects of Quillaja saponins

The implications of feeding saponins include **effects on cholesterol metabolism, cell membrane integrity, immune system, viricidal activity and effects on protozoa**.[8] Although traditionally considered as anti-nutritive components in food and feed, we have shown that the combination of saponins with other phytogenic ingredients such as essential oils stimulate intestinal transporters for glucose and amino acids resulting in improved digestibility.[9]

At Delacon, we are using a unique, well-blended core composition of essential oils and Quillaja saponins. This patented application **enhances the nutritional value of animal diets**. However, a **correctly applied dosing of saponins is of major importance**, as the difference between beneficial and detrimental is narrow.[10]

Effects on the immune system

In general, **Quillaja saponins** are better known for their beneficial effects on animal and human health by their **anti-inflammatory and immunomodulatory actions**. They can prevent many non-specific immune reactions such as inflammation and monocyte proliferation. Pro-inflammatory mediators are down-regulated by natural triterpenoids and are thereby very effective in reducing inflammation.[11] Quillaja saponins increase immune-cell proliferation and boost antibody production.[8]

GOOD TO KNOW

- **First line of defense against common pathogens is given by macrophages and neutrophils of the innate immune system. This system is able to respond very fast and unspecific to a wide range of pathogens. The drawback is however a high cost to the host.**
- **A more specific answer to pathogen defense is provided by lymphocytes of the adaptive immune system, giving additional protection against subsequent reinfection with the same antigen. It offers cheap and specific defense, but a response is delayed by 4 to 7 days upon facing a new pathogen.**
- **The innate immune response is essential to keep infections in control during the time required for the adaptive immune system to adapt to the antigen.**

The effects on immune system and inflammation are not yet fully understood but are most likely mediated by a Quillaja saponins induced production of cytokines such as interleukins and interferons. These small proteins play a crucial role in cell signaling, especially in host responses to infections, immune responses, inflammation, trauma, sepsis, cancer and reproduction.

Effects on ammonia production

Ammonia is a toxic compound that mainly originates from protein metabolism. It is rapidly removed from the circulation by the liver converting ammonia into urea in mammals (uric acid in poultry). Urea and uric acid are then excreted with urine by the kidneys. Micro-organisms can generate ammonia by enzymatic breakdown of urea and uric acid[12] or protein fermentation. Several modes of action have been suggested in the literature on the saponin-induced ammonia reduction in livestock production:

1. Inhibition of the enzymes involved in uric acid and urea degradation, especially urease[12]
2. Direct binding of ammonia[13]
3. Anti-protozoal activity reducing proteolysis of bacterial protein by protozoa, which is of importance especially in ruminants[14]

While the effects of saponins on ammonia have been extensively studied in ruminants, research in monogastric animals on this topic is scarce. In literature, several studies demonstrate the potential of Quillaja saponins **to reduce ammonia production both *in vitro*[4,15] and *in vivo*[7]** in ruminant systems.

The potential of Quillaja saponins to reduce ammonia emissions is also confirmed for monogastric animals by Delacon in our Performing Nature Research Center. *In vivo* trials showed a **consistent decrease of ammonia emissions by Quillaja saponins by 19-27 percent in pigs and 18-65 percent (32 percent on average) in poultry.** Therefore, reduction of ammonia by dietary addition of Quillaja saponins may contribute to the animals' health and lowers the metabolic stress and energy expenditure for detoxification processes of ammonia in the liver. In addition, lower aerial ammonia concentrations, reduce odor emission and irritation of the respiratory tract. This can be helpful especially during winter times in barns when ventilation rates are low, accumulating aerial ammonia to problematic concentrations.

The results of these studies suggest, that in ruminants especially the antiprotozoal effect might be responsible for the observed ammonia reduction, whereas in monogastrics the main effect will be via intestinal bacteria and their metabolic activity. However, only limited data is available in this regards and further studies are required to clarify and improve knowledge on the interaction of saponins with bacterial communities.

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More than just an ingredient for Delacon

Having the power to make an important contribution to animal nutrition and health, Quillaja saponins are a valued ingredient in some of our main products – among more than 100 other ingredients of the phytogenic universe.

Since 2014, Delacon co-owns a Quillaja production site in Chile called Fitotek. The strong partnership with Paolo Tamargo (CEO & co-owner) helps us to ensure the regular supply of Quillaja saponins in a standardized quality.

Fitotek CEO & co-owner Paolo Tamargo (right) and his harvester Don Manuel (left)

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