



Natural protection for superior growth performance

PAQ-Protex™ is a natural feed additive comprising a blend of saponins, a class of chemical molecules abundant in several plant species.

STRUCTURAL DIFFERENCES

Saponins from different sources show different biological effects according to their chemical structures comprising:

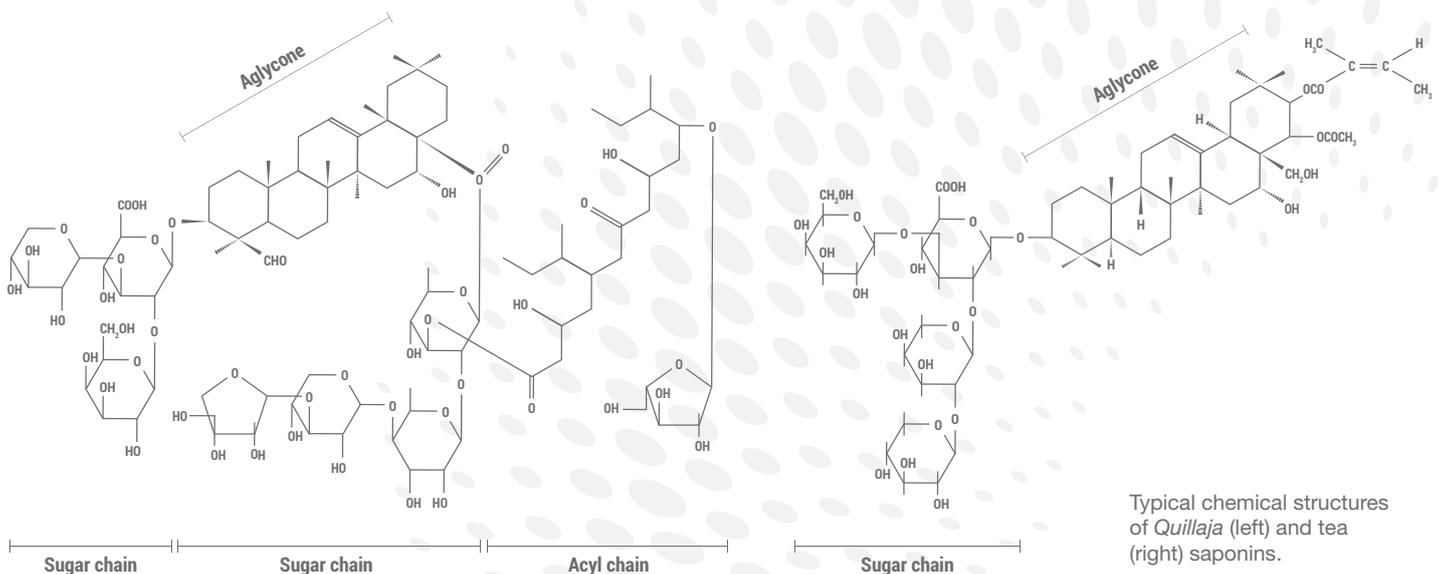
- An aglycone, which is a nonsugar component
- One or more chains of simple sugars
- Other functional groups, such as an acyl group

Quillaja saponins typically have two sugar chains and one acyl functional group attached to the aglycone moiety, while *Yucca* saponins may contain one or two sugar chains. Such functional features help promote:

- Immune response to bacterial infections (*Vibrio* species) in shrimp
- Lower binding to the lipid bilayer of cell membranes and thus lower epithelial permeability compared to that of tea and soy saponins

Quillaja saponin

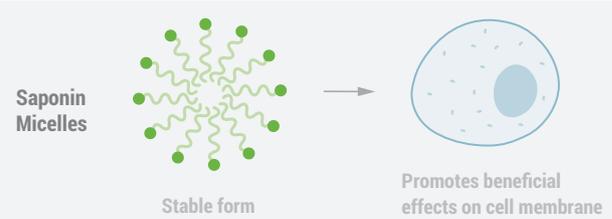
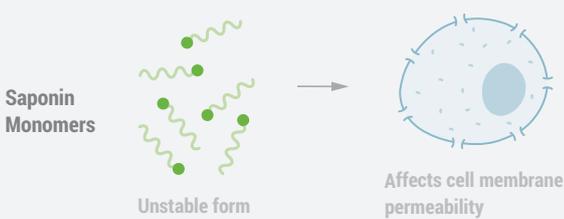
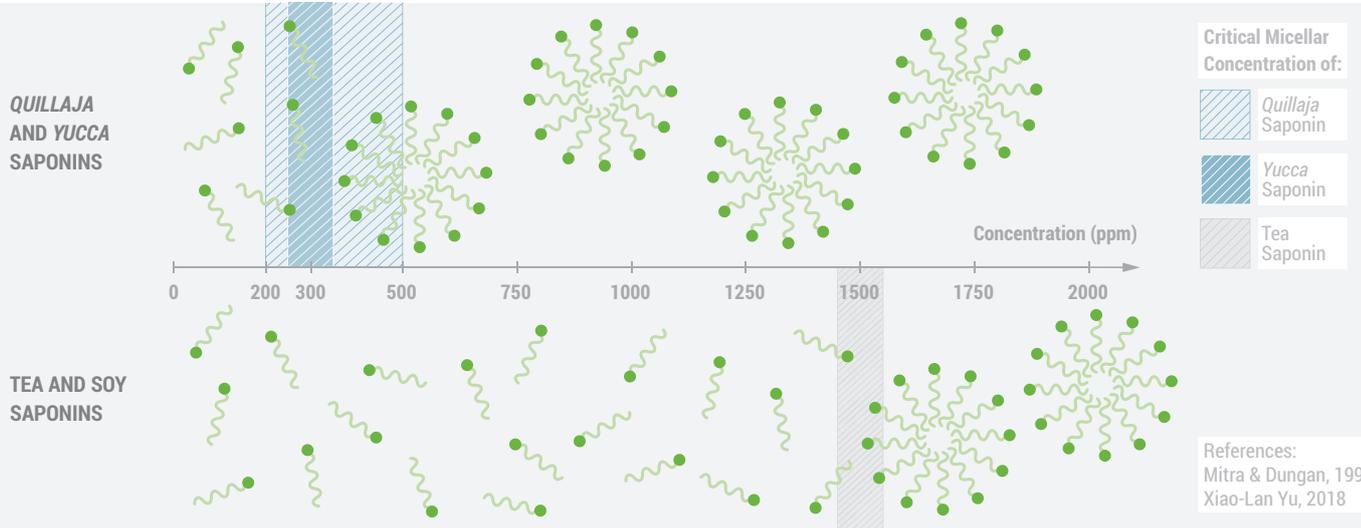
Typical tea saponin



Typical chemical structures of *Quillaja* (left) and tea (right) saponins.

TOXICITY DIFFERENCES

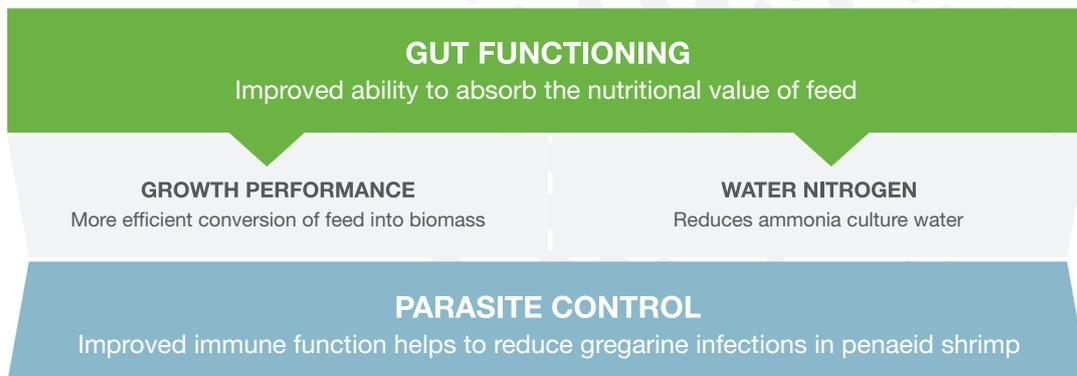
Saponin molecules can form spherical arrangements (micelles) depending on their Critical Micellar Concentration (CMC), which is the minimum environmental concentration at which saponin monomers (unstable form) start aggregating to form micelles (stable form). This threshold measures the capacity of the saponin to reduce surface tension, and the higher this value is, the greater the saponin potential to alter cell membranes and thus the greater its toxicity.



The CMC threshold of *Quillaja* and *Yucca* saponins (top) and tea and soy saponins (bottom) [upper diagram] and the effects of saponin monomers (left) and micelles (right) in cell membranes [lower diagram].

Because tea and soy saponins have high CMCs they are highly toxic to cells, even at low dosage, and pesticides based on these inexpensive compounds are often used to kill predatory fish and snails (Francis et al., 2002).

The *Quillaja*-based feed additive **PAQ-Protex™** shows multiple biological benefits for shrimp:



PAQ-Protex™ is specially designed to provide natural protection for shrimp while promoting growth