

Popular science summary

Plant-based drinks with better protein: is it possible?

Yes. And we can (almost) prove it. Plant beverages can have all the essential amino acids (those our bodies cannot make on their own) in the right amounts, meaning they can be complete protein sources just like cow's milk, when foods such as beans and seeds are combined, as they complete each other's missing amino acids. We set out to make two drinks: hemp-quinoa team on one side, and rapeseed-faba bean isolates on the other, and the result is... that they are extremely close to being complete!

Both drinks have all 9 essential amino acids in almost the perfect ratio for adults, and by that we mean meeting 100% of our body's needs. By combining hemp and quinoa whole seeds, lysine is the only essential amino acid that does not fully reach the target, reaching 96% of the amount adults need. The rapeseed and faba bean isolates make a beverage that is missing a bit of leucine and valine, meeting 99% and 97% of our needs, respectively. These gaps are very small, and a few adjustments to the ingredient ratios and to the formulation could push both drinks toward becoming complete protein sources.

Still, both beverages are already far ahead of most plant milk-alternatives on the market, including oat, almond, and rice drinks. The rapeseed-faba bean drink's nutritional profile is similar to or even better than cow's milk. It has 3.4% protein, the same as cow's milk, but with lower levels of saturated fats and sugar. The quinoa-hemp beverage has less protein (1.1%), but this amount is still higher than almond and rice beverages, and it also has a low fat and sugar content.

Why does any of this matter? A growing number of people are choosing plant-based diets for environmental and ethical reasons, but also for personal health benefits. Sweden's plant-based dairy market alone is estimated at 140 million dollars. However, most plant-based milk alternatives are weak protein sources, with low protein content, incomplete amino acid profiles, and proteins that are difficult to digest. There is a real market gap for plant drinks that can actually compete with cow's milk on protein quality and quantity.

Better protein does not only mean having all the essential amino acids in the right amounts, but it also means making sure that the protein is easy to digest, so that the amino acids are released during digestion, then absorbed, and made available for the body to use. Plant proteins are usually more difficult to digest than animal proteins for a few reasons. One of them is that they contain antinutrients, such as phytic acid, which binds to minerals and proteins and blocks them from being properly digested. For this very reason, we decided to add an extra ingredient to our formulation: phytase, the enzyme that breaks down phytic acid. By breaking down phytic acid, the proteins and minerals are freed and can be digested and absorbed. By reducing phytic acid, we aimed to make the digestion of protein easier.

But how do we know if our plan actually worked? As scientists often do, we simulated the plant-based milk-alternatives' digestion in the lab, analysed the drinks before and after digestion with and without phytase, and then compared results. The enzymatic treatment did reduce phytic acid

in both beverages before digestion in moderate amounts, however, we found no clear evidence that the proteins were digested more easily. We think that not enough phytic acid was reduced, and that it would be interesting to explore if, by accommodating the enzyme to its preferred conditions (it works best in acidic environments, but our drinks are neutral), the phytic acid could be further reduced and perhaps lead to better-digested proteins.

For our beverages, we picked unconventional ingredient combinations, hemp + quinoa and rapeseed + faba bean, that do not exist as commercial products today. We also tried to choose our ingredients based on how sustainable they are. The rapeseed protein isolate (Vertis™ CanolaPRO®) is a certified upcycled plant protein obtained from rapeseed meal, oil extraction leftovers. Faba bean crops have low carbon footprints and fix nitrogen from the air, meaning less fertilisers needs to be used, while hemp is considered a highly sustainable crop because it absorbs and stores carbon dioxide.

This work provides a starting point for researchers and food developers interested in creating better plant-based milk alternatives. It shows that combining plant sources that complete each other's amino acid profiles is a powerful strategy for improving amino acid deficiencies and potentially reaching protein completeness, with careful considerations about the ingredients' ratio. It also provides knowledge on treating foods with phytase as a base for future research into improving plant protein digestibility.