Examine.com

THE DEFINITIVE GUIDE TO WHEY PROTEIN

Like what you see?

Get the Definitive Guide to Whey Protein

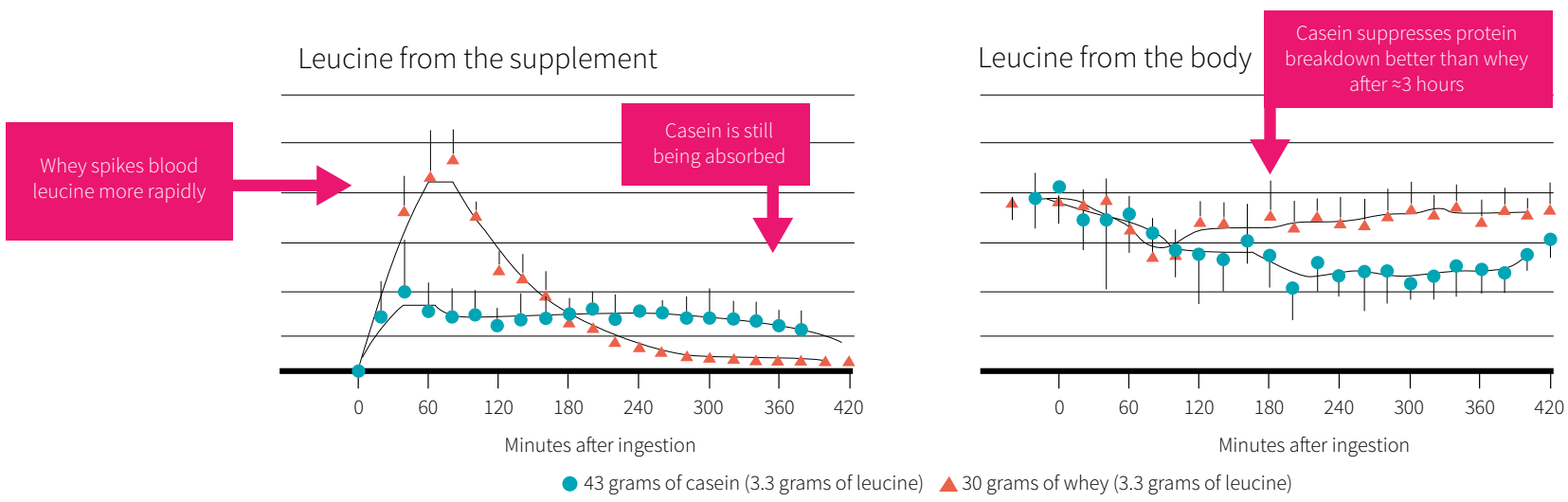
Casein

Casein accounts for 80% of the protein in cow's milk (compared to 30% in human milk, 23% in goat's milk, and 15% in the milk of sheep and buffalo). It is essentially the only protein in cheese (coagulated casein plus milk fat) and strained yogurt (a.k.a. Greek yogurt).

Compared to whey protein, casein is lower in *essential amino acids* (EAAs), notably leucine, and so has lower biological quality. Its speed of digestion and absorption may also be lower, depending on the type of casein powder you choose: micellar casein, casein hydrolysates, and caseinates.

Micellar casein is the form of casein found in milk. It digests very slowly: consuming 40 grams can maintain elevated levels of serum EAAs, notably leucine, for 6–7 hours (compared to about 4 hours for whey).[135,136] This is because, under acidic conditions (as found notably in your stomach), micellar casein coagulates into a blob that is difficult for your digestive enzymes to break down.[137] Unfortunately, slower digestion speed means less stimulation of MPS with micellar casein than with whey protein.[138,139]

Figure 13: Leucine appearance in the blood



Reference: Boirie et al. *Proc Natl Acad Sci USA*. 1997 Dec

The two other forms of casein, caseinates and hydrolysates, are created by destroying the micellar structure of casein, allowing for faster digestion.[137,140] Their digestion speed is, in fact, very similar to that of whey protein. However, whey protein, being richer in EAAs and leucine, still stimulates MPS more than do caseinates and hydrolysates during the first 3 hours after ingestion (and similarly thereafter).[141,142]

Casein has less EAAs, notably leucine, than does whey protein. Micellar casein digests slowly, whereas caseinates and casein hydrolysates digest quickly. None of these forms stimulate MPS more than does whey protein.

Bioactive peptides

Like whey protein, casein is composed of subfractions that form bioactive peptides when digested.[143] In casein, those subfractions are α-, β-, and κ-caseins, from which your digestive enzymes can form peptides that stimulate opioid pathways and benefit your immune and cardiovascular systems.[49,144] Of those peptides, *glycomacropeptide* (GMP) and the β-casomorphins (BCMs) are of special interest.

GMP exists naturally in small amounts in casein powder but comes about primarily through the digestion of κ-caseins. It acts as an antimicrobial, strengthens the immune system, and benefits dental health.[145]

BCMs, which are produced during the digestion of β-caseins, are the peptides with opioid, or morphine-like, properties. Of the various BCMs, only BCM-7 has been heavily investigated, because of associations found with higher risks of certain disorders and diseases, such as autism, cardiovascular disease, and type I diabetes. However, a comprehensive review by the European Food Safety Authority concluded that those associations were based largely on speculation and somewhat conflicting explanations, suggesting that more research into the role of BCM-7 in human health is required.[146]

Several bioactive peptides from casein can benefit your health, but BCM-7, which stimulates your opioid pathways, has been linked to various diseases based on weak scientific evidence. More research is required.

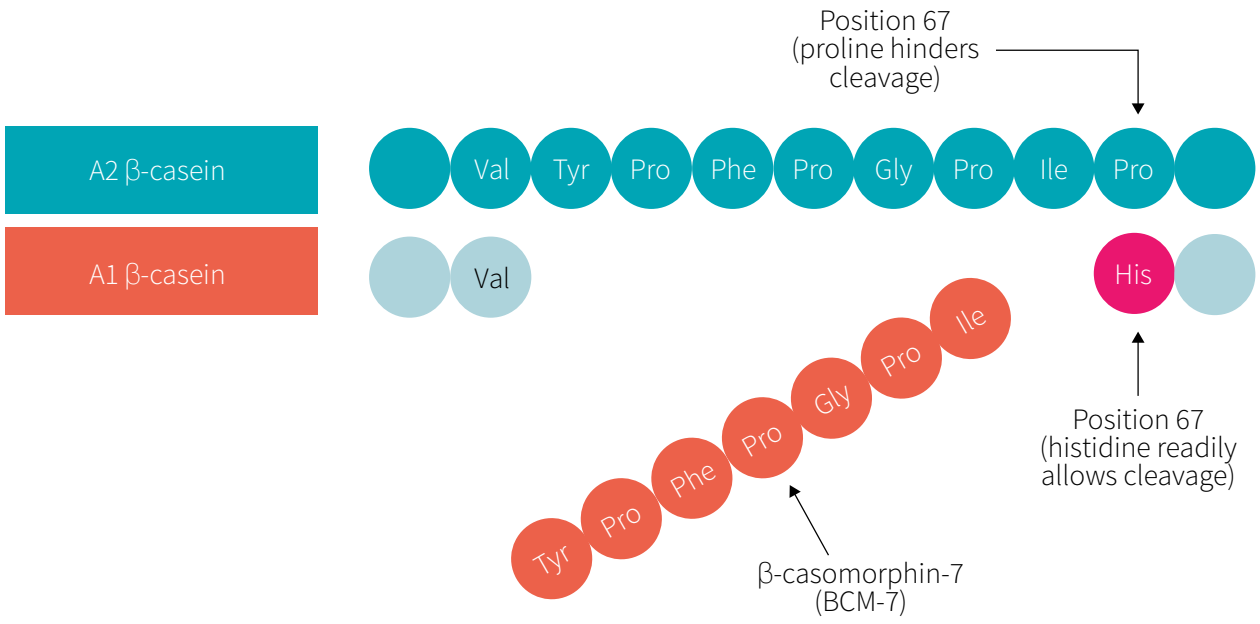
A1 vs. A2 β-casein

There are two types of β-casein protein subfraction: A1 and A2.[147]

A2 is the natural and original form of β-casein. It is the form found in the milk of humans, goats, sheep, and purebred Asian and African cattle. The A1 variant, a genetic mutation, appeared in European cattle about 5,000 years ago. Due to crossbreeding, most dairy products contain both A1 and A2 (both are present in the milk of prominent cattle breeds such as Ayrshire, Guernsey, and Holstein).

The practical difference between the two types of β-casein is that your digestive enzymes can form BCM-7 out of A1, not A2.

Figure 14: Difference between A1 β-casein and A2 β-casein



Although the role of BCM-7 in actual diseases is uncertain, there is consistent evidence from animal studies that consuming A1 promotes inflammation through the binding of BCM-7 to opioid receptors in the gut.[148] Human data are scarce, but the few studies available suggest with moderate certainty that A1 is proinflammatory.[149,150,151,152,153]

In fact, some of these studies suggest that people who believe they are lactose intolerant are actually sensitive to A1 instead; they do not report symptoms of lactose intolerance when drinking milk that contains A2 only.

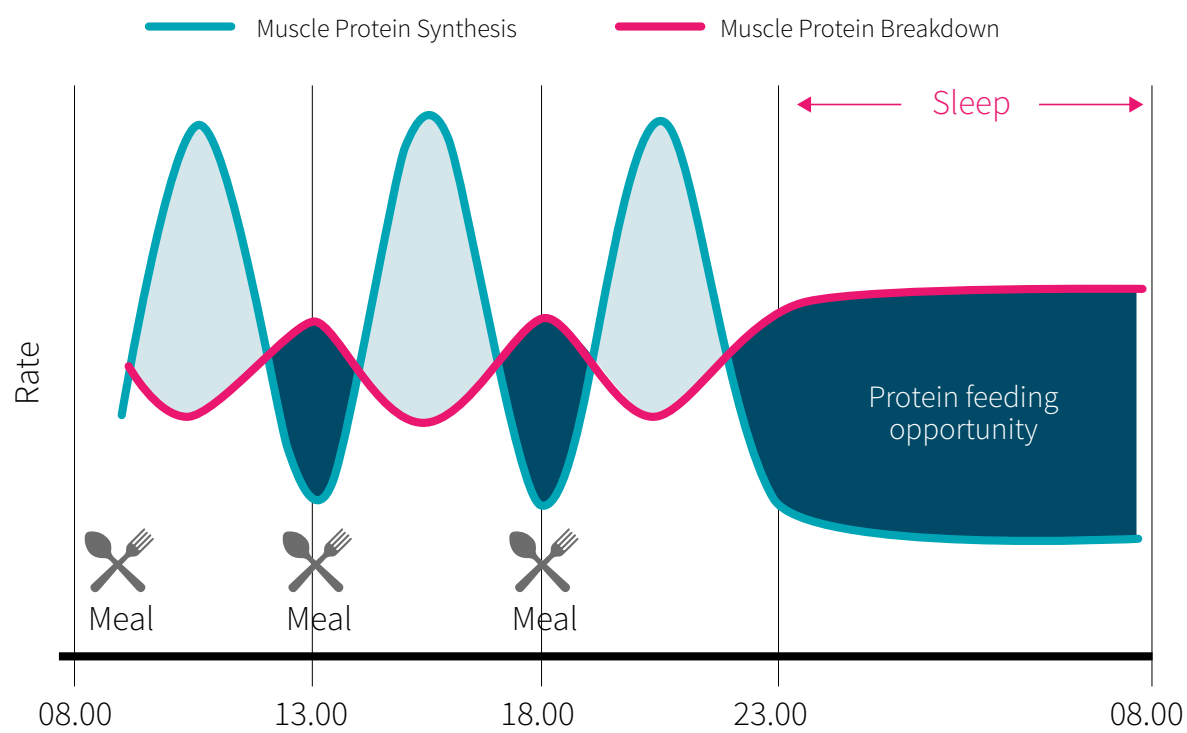
Note that any possible proinflammatory effect may be masked by milk's high nutritional value, since both types of β-casein similarly benefit exercise recovery.[154] If you feel "off" with a regular casein powder, you may want to try one that contains only A2.

A1 β-casein may be more inflammatory than A2 β-casein, but research is preliminary. People who suspect they are sensitive to A1 can try casein powders from animals that produce only A2, such as goats and sheep.

Is there a benefit to taking casein before bed?

The slow digestion of micellar casein has led to the idea that taking this protein before bed could benefit muscle mass and exercise recovery by providing the body with a steady flow of amino acids during a time when fasting normally dominates.[155]

Figure 15: Effects of meals and sleep on muscle protein synthesis and breakdown



Serum levels of EAAs, notably leucine, do stay elevated longer with micellar casein (6–7 hours) than with whey protein (about 4 hours),[136] but those EAAs get incorporated into muscle tissue only for the first 3–4 hours.[136,156] In other words, micellar casein and whey protein increase *muscle protein synthesis* (MPS) for the same length of time.

Three pertinent studies looked at bedtime casein: the first used a casein mix (half micellar, half hydrolyzed); the second, micellar casein; the third, caseinates. Remember that hydrolysates and caseinates digest as fast as whey protein, so much slower than micellar casein.

- Two groups of young men took a powder daily near bedtime — one group took 28 grams of a slow/fast casein mix, the other a placebo. After 12 weeks, the casein group had experienced greater increases in strength and muscle mass.[157]
- Two groups mixing resistance-trained men and women took 54 grams of micellar casein daily — one group in the morning, the other near bedtime. After 8 weeks, strength and body composition still hadn't changed in either group.[158]
- Two groups of resistance-trained young men took 35 grams of caseinates daily — one group in the morning, the other near bedtime. After 10 weeks, strength and muscle size had increased similarly in the two groups.[159]

We notice two things. First, that the two studies that used a fast-digesting protein saw benefits, whereas the study that used solely a slow-digesting protein did not. Second, that the two studies that compared morning and bedtime proteins saw no difference in results.

Although comparing studies with different protocols is always iffy, it seems that speed of digestion matters, whereas time of ingestion does not.

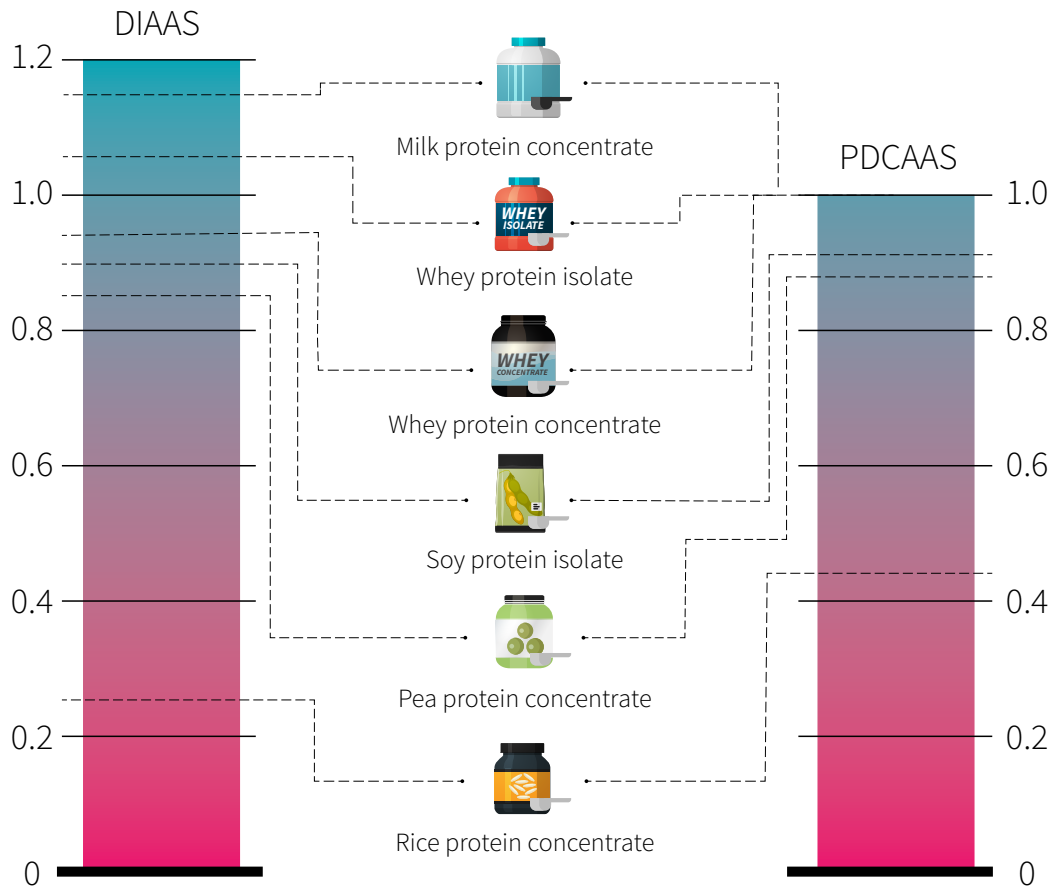
If you haven't consumed enough protein during the day, then taking casein before bed can benefit you, but the same can be said of any other protein.[155] Time of ingestion doesn't seem to matter: whether in the morning or near bedtime, a fast-digesting protein, such as whey protein, seems a better choice for increasing strength and muscle mass than a slow-digesting protein, such as micellar casein.

Milk protein concentrates and isolates

In theory, combining EAA-rich, leucine-rich proteins that have different digestion speeds should offer the best of both worlds: a rapid *and* sustained anabolic response.

The protein in cow's milk naturally contains a 4:1 ratio of micellar casein (slow) to whey protein (fast): on paper, it is ideal. Moreover, according to the DIAAS and PDCAAS scales, which both grade proteins based on their bioavailabilities and amino acid profiles, milk protein is indeed superior to whey protein.

Figure 16: Proteins ranked by bioavailability and amino acid profile



DIAAS stands for Digestible Indispensable Amino Acid Score. To measure a protein's bioavailability, this scale compares how much protein was ingested with how much protein is left after leaving the small intestine.

PDCAAS stands for Protein Digestibility-Corrected Amino Acid Score. To measure a protein's bioavailability, this scale compares how much protein was ingested with how much protein is left after leaving the body.

Source: Shane Rutherfurd et al. *J Nutr*. 2015 Feb

A good number of studies have compared milk protein with soy protein, or soy-dairy protein blends with whey protein, but not many have compared milk protein with whey protein. In one such study, 20 grams of each led to similar increases in MPS over the 3.5-hour measurement period.[160] In another, 20 grams of each taken twice daily for 12 weeks led to similar increases in muscle mass and strength, when combined with resistance training.[161]

Drinking your own 1:1 blend of whey protein and micellar casein, you can expect an increase in serum EAAs, including leucine, that is as fast as whey's but lasts several hours longer.[162]

Finally, a double-blind randomized controlled trial of resistance-trained men undergoing a supervised 9-week training program found similar increases in strength and lean mass between groups supplementing with either 20 grams of whey protein, 10 grams of whey protein with 10 grams of micellar casein (1:1 ratio), or 4 grams of whey protein with 16 grams of micellar casein (1:4 ratio — the same ratio as in milk).[163]

So it appears that a 4:1 casein:whey blend, a 1:1 casein:whey blend, and whey protein alone exert similar benefits on muscle mass and strength. However, we've seen that, whether in the morning or near bedtime, the fast-digesting whey protein seems a better choice for increasing strength and muscle mass than the slow-digesting micellar casein.

We can tentatively conclude that, though digestion speed does matter, you don't need a lot of fast-digesting protein to maximize MPS. As long as your protein blend contains enough whey, the quality of the rest of the protein still matters, but not its digestion speed. It means that you could take milk protein instead of whey protein — but it also means that taking milk protein, or any complicated "time-release" blend of different proteins, has no benefit over taking just whey protein.

Milk protein has a 4:1 ratio of micellar casein to whey protein. Milk protein, whey protein, and a 1:1 blend of micellar casein and whey protein lead to similar increases in muscle mass and strength. It appears that, given proteins of similar quality, a blend of slow- and fast-digesting proteins won't benefit your muscles more than just a fast-digesting protein.