HYPNOS

- A quality **pre-sleep protein**

An article by Professor Don Maclaren, 2017

Many studies have focused on the benefits of whey protein to stimulate muscle protein synthesis (MPS) as well as to attenuate muscle protein breakdown (MPB) with an overall positive Net Protein Balance (NPB). This is quite natural since whey protein has a higher amount of BCAAs and EAAs than other sources of protein (see Science Behind “Big Whey”). Does that mean that other sources of protein, such as casein, should be disregarded? The simple answer is No. In this article, the facts about casein are reviewed as well as its potential as a sound pre-bedtime protein source.

Casein

Casein is an important protein constituent of milk (Figure 1), in which it can be seen to make up 80% of milk protein as opposed to 20% being whey protein. The Science behind articles on “Milk Proteins” and “Whey vs Casein” should be examined for more detail.

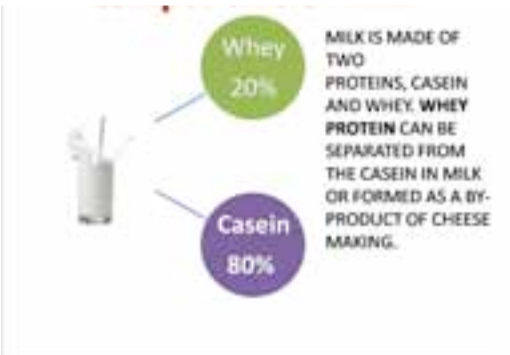

Figure 1. Components of Milk.

As previously described, the amino acid composition of casein is not as high in either the EAAs or the BCAAs (Table 1). This would suggest that casein is an ‘inferior’ source of protein than whey. To an extent this is true, although the fact that casein curdles in the stomach and is slower to digest and absorb may present some beneficial feature under certain circumstances. In effect, casein is a slow-release protein which could be useful as a protein source at bedtime.

Table 1. The amino acid compositions of Whey and Casein.

	Amount (in grams) per 100 g Protein	
Concentration	**Whey**	**Casein**
Alanine	4.66	2.84
Arginine	2.65	3.31
Asparagine	11.25	6.71
Cysteine	2.65	0.35
Glutamine	16.58	20.61
Glycine	1.78	1.73
Histidine	2.25	2.87
Isoleucine	5.72	5.03
Leucine	11.77	8.77
Lysine	9.68	7.44
Methionine	2.10	2.71
Phenylalanine	3.54	4.80
Proline	4.62	10.10
Serine	4.78	5.73
Threonine	5.05	3.97
Tryptophan	2.04	1.16
Tyrosine	3.59	5.38
Valine	5.29	6.46
Total	**100**	**100**
EAA	**50.09**	**46.53**

EAA, essential amino acids

Muscle protein

A single session of exercise stimulates the rate of MPS, and to a lesser extent, MPB (Phillips et al., 1997). As reported in the article on “Big Whey”, if the exercise is undertaken in the fasted state there is a negative NPB. Protein ingestion stimulates

MPS and inhibits MPB, resulting in a positive NPB and so leads to net muscle protein accretion during the acute stages of post-exercise recovery. Consequently, post-exercise protein ingestion is widely applied as a strategy to stimulate MPS and, as such, to facilitate the skeletal muscle adaptive response to exercise training. Various factors have been identified which can modify the post-exercise muscle protein synthetic response to exercise. These include the amount, type, timing, and distribution of protein ingestion.

A large variety of dietary protein sources have been shown to stimulate post-exercise muscle protein synthesis rates, including egg protein, whey and casein, milk and beef protein, and soy protein. However, dietary protein sources can differ in their capacity to stimulate MPS, which is largely dependent on differences in rates of protein digestion and absorption as well as their amino acid composition, with the leucine content being of particular relevance.

Besides the amount and type of ingested protein, the timing and distribution of protein ingestion throughout the day can modulate post-exercise muscle protein synthesis rates. An even distribution of total protein intake over the three main meals stimulates 24 h muscle protein synthesis rates more effectively than an unbalanced distribution in which the majority (>60%) of total daily protein intake is consumed at the evening meal. During 12 h of post-exercise recovery Areta et al., (2013) showed that an intermediate pattern of protein ingestion (20 g every 3 h) increases MPS to a greater extent than the same amount of protein provided in less frequent but larger amounts (40g every 6 h), or in more frequent, smaller amounts (10g every 6 h). Therefore, an effective pattern of daily protein intake distribution to support MPS is to provide at least 20g of protein with each main meal with no more than 4–5 h between meals.

Since overnight sleep is likely to be the longest post-absorptive period during the day, the concept of protein ingestion prior to sleep as a means to augment post-exercise overnight MPS needs to be considered.

Overnight Protein Metabolism

In general, most studies assess the effects of food intake on the MPS response to exercise performed when in an overnight fasted state. Such conditions differ from normal everyday practice in which training is often performed in the morning and/or afternoon or in the evening after a full day of habitual work and food intake.

Beelen et al., (2008) evaluated the impact of exercise performed in a fed state in the evening and the efficacy of protein ingestion immediately after exercise on muscle protein synthesis during overnight recovery. The ingestion of 20–25 g of protein during exercise increased MPS during the exercise bout, but no increase was observed during the prolonged overnight recovery period. In this investigation the MPS during overnight sleep was unexpectedly low, with values being lower than those observed in the in the morning following an overnight fast. Thus, a day of habitual food intake and the ingestion of 20–25g of protein during and/or immediately after an exercise bout performed in the evening does not appear to promote overnight muscle protein reconditioning.

Could these results be due to the gut not functioning optimally during sleep? In order to check for that, Groen et al., (2012) gave 40g of casein via a nasogastric tube while participants slept. They found that such a feeding strategy resulted in normal digestion and absorption, and they concluded that the gut does function normally at night when asleep if fed.

Protein feeding before sleep as a strategy to increase MPS

The first investigation to examine if protein feeding before sleep was of benefit after an evening training session was undertaken by Res et al., (2012). Recreational athletes were studied during overnight recovery from a single bout of resistance exercise performed in the evening after a full day of a standardised dietary intake. Immediately after exercise, all athletes ingested a recovery drink containing 20g of protein to maximize MPS during the acute stages of post-exercise recovery, and this was followed by either 40g casein or a placebo drink immediately prior to sleep. The protein ingested prior to sleep was observed to be properly digested and absorbed throughout overnight sleep. The greater plasma amino acid availability following pre-sleep protein ingestion improved the overnight whole-body protein balance, allowing the NPB to become positive. MPS was approximately 22% higher during overnight recovery when protein was ingested prior to sleep when compared to the placebo treatment. Figure 2 shows the positive effect of casein ingestion on overnight muscle protein synthesis compared with placebo. From these data the authors concluded that “pre-sleep protein ingestion represents an effective dietary strategy to further augment the skeletal muscle adaptive response to resistance-type exercise training”.

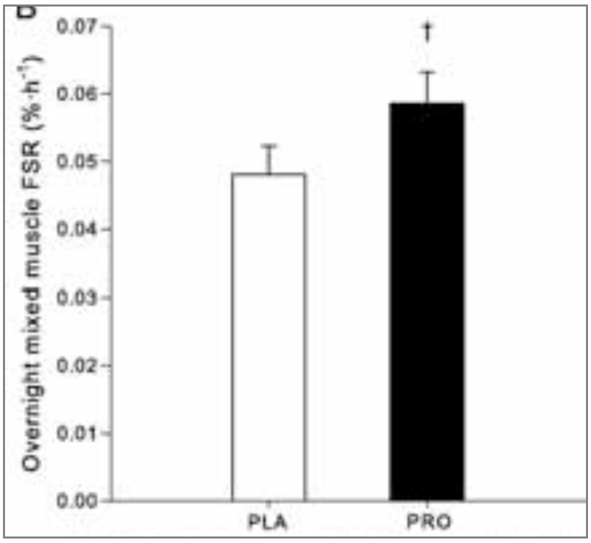

Figure 2. Efficacy of casein feeding (PRO) before sleep on overnight MPS compared with placebo (PLA).

As a consequence, Trommelen & van Loon (2016) produced a schematic (Figure 3) to highlight the variation in MPS as a consequence of feeding through the day as well as feeding casein (or not ‘A’) before sleep.

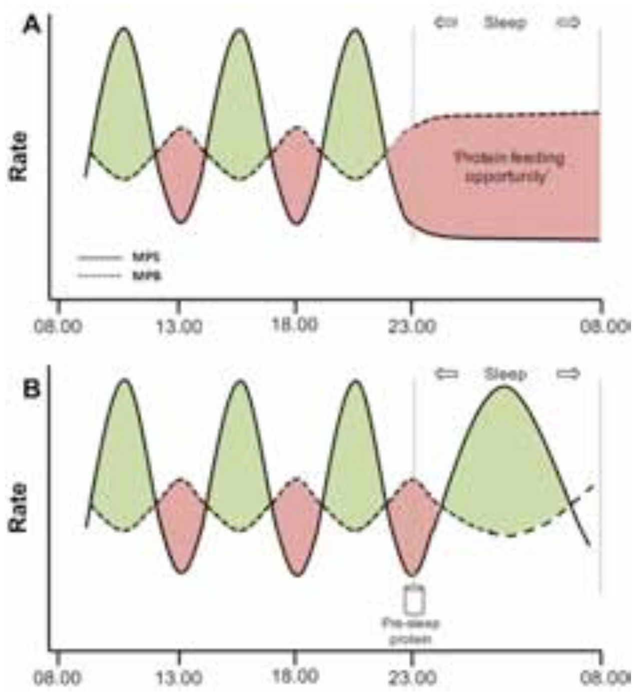

Figure 3. Schematic of MPS and MPB throughout the day. Protein ingestion stimulates MPS rates and allows for net muscle protein accretion (green areas). During the post-absorptive phases MPB exceeds MPS resulting in net loss of protein (red areas). Overnight sleep is the longest post-absorptive period (A). Protein ingested before sleep stimulates overnight MPS and so enhances muscle recovery during sleep (after Trommelen & van Loon, 2016)

More recently, Snijders et al., (2015) selected healthy young men in a 12-week resistance exercise training program (three exercise sessions per week) during which they ingested either 27.5g of casein prior to sleep, or a non-caloric placebo. Muscle mass and strength increased to a greater extent in the group that ingested protein prior to sleep (Figure 4). These results indicate that protein supplementation prior to sleep represents an effective dietary strategy to enhance the gains in muscle mass and strength during resistance training.

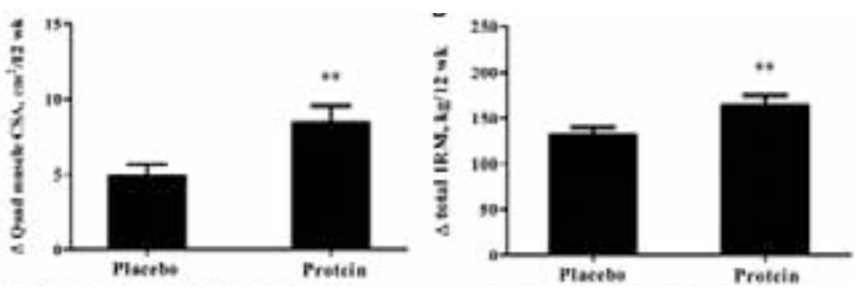

Figure 4. Change (Δ) in quads muscle cross section area (CSA) and also in 1 repetition maximum (1-RM) from casein or placebo taken before sleep during 12 weeks training programme (after Snijders et al., 2015).

It should be noted that the ingestion of the pre-sleep casein supplements in both the acute and long-term studies were compared with a non-protein placebo, and not compared with protein supplementation provided at other time points. Therefore, the benefits of pre-sleep protein provision have to be treated with some caution. As such, additional pre-sleep protein ingestion represents a practical strategy to increase the total daily protein intake, add another meal, and increase the overnight MPS. This effect is likely to be additive to MPS observed throughout the day.

While the overnight sleeping period can be seen as a new window of opportunity to augment post-exercise training adaptations, it remains to be established how much casein is required to maximize the impact of pre-sleep protein feeding on overnight MPS. The ingestion of 40g casein prior to sleep stimulates overnight MPS is considerably more than the 20 g of protein that is supposed to maximize MPS during the first few hours of post-exercise recovery in the day. Would a lower dose of casein be just as useful?

Trommelen & van Loon (2017) addressed this issue by performing a study in which they provided 30g casein prior to sleep, with or without an additional 2g of free leucine. In contrast to previous findings with 40g protein, the ingestion of 30g protein prior to sleep did not significantly increase overnight MPS. This suggests that a pre-sleep protein dose-response relationship exists, and that this differs from the immediate post-exercise recovery period during which the ingestion of 20g protein seems to maximize post-exercise muscle protein synthesis rates in young adults.

The authors also observed that the ingestion of casein was incorporated into new (*de novo*) muscle protein following overnight recovery. So, casein before sleep provides amino acids as precursors for *de novo* myofibrillar protein accretion during overnight sleep. This supports observations that the ingestion of 30g protein prior to sleep promotes muscle mass during 12 weeks of resistance-type exercise training (Snijders et al., 2015). However, data suggest that at least 40g of pre-sleep protein is required to induce a more substantial and detectable increase in MPS when assessed acutely over a 7.5-h overnight period.

The 30g of casein before sleep might not be sufficient to adequately increase overnight MPS, and that is why Trommelen et al., (2017) included a treatment in which 2 g crystalline leucine was added to the 30g of protein. The addition of supplemental free leucine to a suboptimal amount of protein has been shown to enhance post-exercise MPS in previous studies but failed to do so in this overnight feeding study. Given the extended duration of overnight sleep compared to a typical postprandial period (8 vs. 4–5 h), it is tempting to speculate that larger amounts of protein (≥40 g) are required to maximize muscle protein synthesis rates during overnight sleep.

Type of Pre-Sleep Protein

As protein sources differ in their capacity to stimulate MPS, the type of protein ingested prior to sleep may modulate the overnight muscle protein synthetic response. So far, all studies assessing the efficacy of pre-sleep protein ingestion on exercise reconditioning have used casein. Casein is a more slowly digestible protein source, allowing a more moderate but prolonged rise in plasma amino acid concentrations (see Figure 5). Given the extended nature of overnight sleep (~8-h), it could be speculated that a more sustained postprandial increase in available amino acids during overnight sleep is preferred as it will provide precursors to support MPS throughout the night. In contrast, whey protein is a more rapidly digestible protein, resulting in a pronounced but transient rise in plasma amino acid concentrations. Ingestion of a single bolus of whey protein has been shown to stimulate muscle protein synthesis rates to a greater degree than casein over periods up to 6 h. It remains to be established if whey is superior to casein when ingested prior to sleep and MPS are assessed over a more prolonged overnight period of 7.5 h.

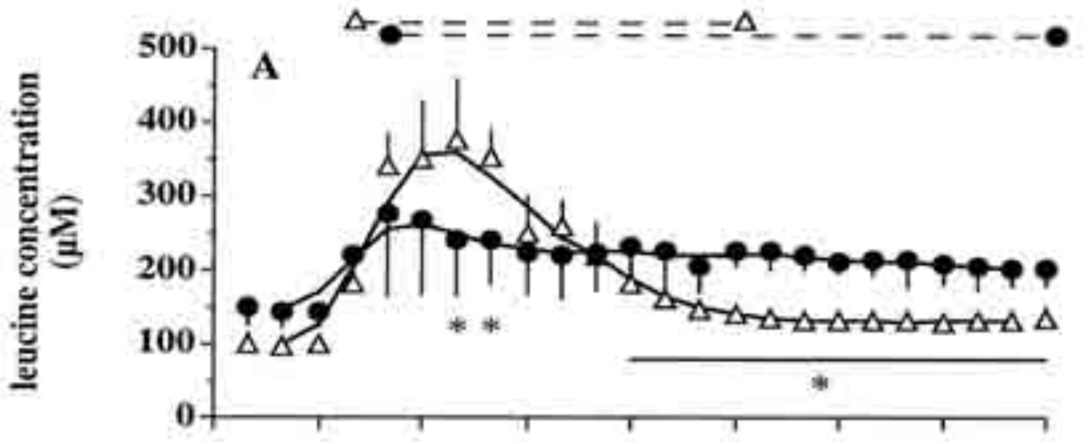

Figure 5. Plasma leucine concentrations after a labelled Whey and a Casein meal (from Boirie et al. 1997).

Conclusions

MPS is particularly low during sleep, even when 20g protein is ingested immediately after exercise performed in the evening. Protein ingested immediately prior to sleep is effectively digested and absorbed, and so increases amino acid availability during overnight sleep. Greater amino acid availability during sleep stimulates MPS and improves whole-body NPB during overnight recovery. At least 40g of dietary protein should be ingested prior to sleep to stimulation of MPS throughout the night. Resistance exercise performed during the day enhances the overnight MPS response to pre-sleep protein ingestion and allows more of the protein-derived amino acids to be used as precursors for *de novo* muscle protein synthesis. When applied during prolonged resistance-type exercise, pre-sleep protein supplementation can be used effectively to further increase gains in muscle mass and strength.

Key Points

- Casein is a slow release protein in comparison with whey
- Casein is the protein of choice in research using a protein source before sleep
- There is clear evidence that when casein is ingested before sleep, it is digested, absorbed and leads to increased amino acid availability for muscle recovery
- A combination of casein and resistance exercise in the evening leads to an increase in muscle

- A dose of 40g of casein is deemed desirable before sleep in order to promote muscle protein accretion

"NutritionX Hypnos is an ideal casein-containing protein to aid recovery overnight"

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