Protein Supplements: Do They Alter Dietary Intakes?

Alistair R. Mallard, Rebecca T. McLay-Cooke, and Nancy J. Rehrer

Effects of protein versus mixed macronutrient supplementation on total energy intake (TEI) and protein intake during an ad libitum diet were examined. Trained males undertook two, 2-week dietary interventions which were randomized, double blinded, and separated by 2 weeks. These were high-protein supplementation (HP: 1034.5 kJ energy, 29.6 g protein, 8.7 g fat and 12.3 g CHO) and standard meal supplementation (SM: 1039 kJ energy, 9.9 g protein, 9.5 g fat, and 29.4 g CHO) consumed daily following a week of baseline measures. Eighteen participants finished both interventions and one only completed HP. TEI (mean ± SD) was not different between baseline (11148 ± 3347 kJ) and HP (10705 ± 3143 kJ) nor between baseline and SM (12381 ± 3877 kJ), however, TEI was greater with SM than HP (923 ± 4015 kJ p = .043). Protein intake (%TEI) was greater with HP (22.4 ±6.2%) than baseline (19.4 ± 5.4%; p = .008) but not SM (20.0 ± 5.0%). No differences in absolute daily protein intake were found. Absolute CHO intake was greater with SM than HP (52.0 ± 89.5 g, p = .006). No differences in fat intake were found. Body mass did not change between baseline (82.7 ± 11.2 kg) and either HP (83.1 ± 11.7 kg) or SM (82.9 ± 11.0 kg). Protein supplementation increases the relative proportion of protein in the diet, but doesn’t increase the absolute amount of total protein or energy consumed. Thus some compensation by a reduction in other foods occurs. This is in contrast to a mixed nutrient supplement, which does not alter the proportion of protein consumed but does increase TEI.

**Keywords:** energy intake, macronutrient intake, body composition

There is a long history of athletes including protein supplements in their diet. Protein supplementation has been studied since the first introduction into athlete diets almost 70 years ago. Many athletes will supplement with protein in addition to whole foods to achieve macronutrient requirements and for convenience. The body of research investigating the addition of protein to a diet is extensive. Protein synthesis can be enhanced through judicious supplementing with protein, particularly if combined with resistance or strength-based training. Enhanced protein synthesis contributes to increased net positive protein balance and underpins muscle hypertrophy (Wolfe, 2000). There is some evidence that animals eat to meet their protein needs and to achieve this, energy intake may be greater than what is necessary to maintain energy balance as many foods contain a mixture of macronutrients (Du et al., 2000; Summers et al., 1992; Webster, 1993).

Recommendations for protein intake vary widely. It is recommended that males undertaking endurance training consume 1.6 g/kg/d, and those undertaking resistance training consume 1.5–1.7 g/kg/d (Tarnopolsky, 2010; Wolfe, 2000). This is in contrast to the recommendation for the general population (nontraining) of 0.8 g/kg/d for males 19–50 years of age (Institute of Medicine, Food and Nutrition Board, 2005). The timing of ingestion also appears to be important in that acute ingestion after training enhances amino acid transport and protein synthesis (Biolo et al., 1997). The majority of protein supplements readily available to the public are derived from whey. There are some products that use casein as a protein source but whey protein has been shown to have a much higher leucine content and quicker digestion and absorption kinetics (Pennings et al., 2011). Liquid supplements are more common than solid supplements due to ease of consumption and may be more quickly digested and absorbed as gastric emptying is greater than that of solids with a similar nutrient content (Kunz et al., 1999).

In most studies investigating protein intake and muscle hypertrophy, dietary intakes are strictly controlled. This includes keeping energy yielding nutrients (proteins, carbohydrates, fats, and alcohol) and total energy intake (Cribb et al., 2006), as well as amount of exercise (Tang et al., 2007), constant in both the supplement and non-supplement conditions. It is, however, unknown if a supplement leads to an increase in total protein intake and/or if energy balance is altered when dietary intake, outside of supplementation, is ad libitum.

Studies have also been conducted to assess the effect of protein supplementation on weight-loss. Some have concluded that addition of a protein supplement to an energy restricted diet can increase fat loss and spare lean...
muscle (Paddon-Jones et al., 2008), although this is not always observed (Pal et al., 2010). Proposed mechanisms for this potential impact on weight loss include effects of protein supplementation on satiation (feeling of fullness) compared with carbohydrate/fat, possibly caused by changes in sensitivity to leptin and secretion of peptide YY3–36 (Ritter, 2004). Results to date have proved inconsistent (Rolls et al., 1988; Rumpler et al., 2006).

The purpose of the current study was to investigate whether a liquid (whey) protein versus a standard mixed macronutrient (‘Milo’) supplement alters total macronutrient or energy intake in a free-living situation in which all other daily food intakes are not prescribed.

**Materials and Methods**

**Study Design**

A randomized, double-blind, cross over experimental design was used in which each participant completed two, 2-week, dietary interventions over 7 weeks. During each intervention participants consumed either a high protein (HP) or mixed macronutrient, standard meal (SM) supplement daily. The dietary interventions were preceded by a week-long baseline period and were separated by a 2-week washout period.

**Participants**

Nineteen trained healthy males aged 20–43 years were recruited to take part in this study. Criteria for inclusion in the study included no protein supplementation in the last six months, engagement in at least five hours of physical activity per week, BMI of < 30 and > 18.5 and no cardiopulmonary or kidney disease. Participants were also required to have a maximal oxygen uptake (VO2max) > 35 ml O2/kg body mass/min. Participants were not asked if they were trying to gain or lose weight. The study was approved by the University of Otago ethical committee and participants were informed and gave written consent.

**Participant Characteristics**

Body mass and height were measured upon recruitment and immediately before and after each supplement period. Maximum oxygen consumption (VO2max) was measured in all participants during an incremental cycling test (Kuipers et al., 1993) before baseline activity and dietary monitoring commenced. This test was performed using open circuit spirometry (Cosmed Cardio Pulmonary Exercise Testing, CosmedSrl, Rome, Italy) on an electronically braked cycle ergometer (Velotron Basic, RacerMate Inc., Seattle, Washington, USA).

**Diet Monitoring**

All individuals were asked to record quantities of all food and liquid consumed for 3 weekdays and one weekend day during the baseline week and during the second week of each 2-week intervention. Participants could choose which days to record diet data but were asked to use the same days of the week for subsequent recordings. A diary, scales (Salter Electronic Silicone Platform Kitchen Scale No1017, Dandenong South, Australia) accurate to 1.0 g and a diet assessment photo booklet of common portion sizes (Department of Human Nutrition, University of Otago, Dunedin, New Zealand) were given to each participant. A training session was also conducted with each participant on how to measure and record quantities and details of foods and liquids.

**Activity Monitoring**

Participants wore accelerometers (New Lifestyles NL-1000, New Lifestyles Inc., Missouri, USA) each day while awake and not immersed in water, clipped on to clothing at the hip. Participants were also required to record all exercise in a diet and exercise record booklet undertaken during the 7-day baseline period. Participants were asked for length of activity, intensity, and type of exercise (also sets and reps for resistance activities). Activity monitoring was repeated daily during each of the dietary interventions.

**Supplementation Intervention**

The two supplementation regimens were a high protein supplement (HP) which comprised 30 g of Horleys (NaturAlac Nutrition Limited, Auckland, New Zealand) 100% Whey Protein (chocolate flavor) and 200 ml of whole milk which together provided 1034.5 kJ energy, 29.6 g protein, 8.7 g fat and 12.3 g carbohydrate (CHO) per serve, and a more balanced mixed nutrient, standard meal supplement (SM) which comprised 30 g of Milo (Nestlé, Auckland, New Zealand) and 200 ml of whole milk and provided 1039 kJ energy, 9.9 g protein, 9.5 g fat, and 29.4 g CHO per serve. Milo with whole milk was chosen as the standard meal supplement as the serving size was the same as that of the high protein supplement while yielding similar energy content but with a ratio of macronutrients similar to that contained in the average New Zealand diet (University of Otago and Ministry of Health, 2011). The supplements were repackaged in clear plastic bags with a supply for 15 days (420 g; one extra day in case of spillage), which were placed in an opaque bag along with 3 L of whole milk and labeled by participant’s name. Bags were weighed upon return to ensure participants’ compliance. These were prepared by a technical staff member who was not involved in data analysis or any other aspect of the study therefore blinding the researchers.

Each supplement was consumed daily for 14 days (mixed by participants). The supplement was to be taken within 20 min of completion of a training session. If no training took place participants were asked to take the supplement at the time of day that training normally occurred. As training was not prescribed, this varied between individuals.
Data Analysis

Nutrient composition of the baseline and intervention diets were calculated using Diet Cruncher (Version 1.7.0, Way Down South Software, Dunedin, New Zealand), a dietary analysis program that uses food composition data from the New Zealand Institute for Crop and Food Research Ltd (FOOD6files, 2006). All diet records were coded and entered by the same researcher. Values presented in tables and figures are means (± SD) and confidence limits were set at 95%. SPSS (Version 19.0, SPSS Inc, Chicago, IL) was used to conduct Linear Mixed Model analysis with factors of subject (maximum 19 subjects), and repeated measurement factors of dietary intervention (maximum 3 levels) and order (2 levels) for each measure. The independent variable was dietary intervention (baseline, SM, HP) and the dependent variables were energy, fat, protein and CHO intake. The levels of significant main effects for each factor were compared using the post hoc Bonferroni comparison test. Mixed model analysis using a compound symmetry model was performed on individual macronutrient intake as a % of energy intake, macronutrient intake (g), macronutrient intake per kilogram of body mass (g/kg), body mass, steps taken, energy intake, and sum of skinfolds. A log transformation was applied to protein (g), protein (g/kg), fat (g), and fat (g/kg). Low energy reporting was assessed using the Goldberg method at an individual and group level as outlined by Gibson (2005). The FAO/WHO/UNU (1985) equations were used for the prediction of basal metabolic rate (BMR_{ calibrated}). A cut-off of 1.42 (EI:BMR_{ calibrated}) was used based on a sample size of 19 and 4-day diet record collection for the group and a cut-off of 1.06 (EI:BMR_{ calibrated}) for individuals based on a 4-day diet record collection. BMI was calculated from weight and height. Significance was recognized as \( p < .05 \).

Results

Participants

Participant characteristics are presented in Table 1. One subject did not complete the study by not undertaking the SM supplementation and, thus, for this intervention dietary analyses are for \( n = 18 \).

Total Energy and Percentage Intakes

There was no difference between baseline total energy intake (TEI) and HP energy intake or between baseline and SM (Figure 1). However, the TEI during HP was lower \( (p = .043) \) than during SM. As a percent of energy intake, there was 2.95% more \( (p = .008) \) protein consumed during HP than at baseline (Table 2). There was no significant difference in protein intake between baseline and SM as a percent of energy intake (Table 2). When calculated as a percent of TEI no difference was observed in fat intake between baseline and SM or baseline and HP (Table 2). When calculating CHO intake as a percent of TEI there was no significant difference between baseline and HP or baseline and SM (Table 2). When calculated as a percent of TEI there were no differences in alcohol intake observed between baseline and HP or baseline and SM.

Analysis for under-reporting using the aforementioned Goldberg cut-offs revealed that at baseline four individuals (21%) were below the cut-off but the group was above. The HP records indicated six individuals (31.6%) were below the cut-off and as a consequence the group was also below. The SM records indicated six individuals (33.3%) were below the cut-off, but the group was above. The four individuals identified as low-energy reporters during HP and SM.

Absolute Intakes

Absolute protein intake did not differ between baseline and HP, but there was a trend toward a greater absolute protein intake with SM than at baseline \( (p = .067; \text{Figure} 2) \) with no difference in the absolute amount of protein consumed between HP and SM. When protein intake was calculated in terms of grams per kilogram body mass there was no significant difference between baseline and HP or baseline and SM (Table 2).

There was a trend for absolute fat intake to be greater with SM than with HP \( (p = .065; \text{Figure} 2) \) but there was no difference from baseline for either SM or HP. This trend for an increase in fat intake in SM compared with HP continued when calculated as grams per kilogram body mass \( (p = .054; \text{Table} 2) \) but no difference was observed between either SM or HP and baseline. Absolute CHO intake was greater in SM than HP by 62.5 g \( (p = .006; \text{Figure} 2) \) but was not different between HP and baseline nor SM and baseline. There was also a greater relative CHO intake \( (0.88 \text{g/kg/d}; p = .033) \) with SM than

### Table 1 Participant Physiological and Anthropometric Characteristics

<table>
<thead>
<tr>
<th>Participant Characteristics</th>
<th>Mean ± SD</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>22 ± 5</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>82.6 ± 10.9</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.81 ± 0.07</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.1 ± 2.5</td>
</tr>
<tr>
<td>VO₂_{max}—absolute (L·min⁻¹)</td>
<td>2.99 ± 0.33</td>
</tr>
<tr>
<td>VO₂_{max}—relative (ml·kg·min⁻¹)</td>
<td>36.72 ± 3.56</td>
</tr>
<tr>
<td>Endurance traineda</td>
<td>7</td>
</tr>
<tr>
<td>Resistance trainedb</td>
<td>7</td>
</tr>
<tr>
<td>Endurance/Resistance trained</td>
<td>5</td>
</tr>
</tbody>
</table>

aEndurance exercise included team sports or any continuous exercise > 20 min.
bResistance exercise was defined as gym based resistance exercise.
There were no differences found in absolute alcohol intake between baseline and SM, baseline and HP, or SM and HP. There were also no differences observed when alcohol intake was calculated relative to body mass between baseline and HP and SM.

**Effects of Supplementation on Meal Intakes**

No differences in protein or energy intakes across meals (breakfast, lunch and dinner) were observed with supplementation versus baseline (Table 3). The nutrient intakes with and without supplement included are presented in Table 3. Although there are large variations in intakes between and within individuals, supplementation, particularly with HP, tended to reduce nutrient intake from other foods.

**Body Mass and Daily Activity**

There was no change in body mass after 14 days of supplementation with either HP (pre: 82.26 ± 11.19; post: 82.24 ± 10.41) or SM (pre 81.97 ± 10.27; post 81.99 ± 10.29). Activity levels of participants during baseline and SM and HP interventions also remained constant. There were no significant differences in steps between baseline and HP and SM (9489 ± 3940, 8668 ± 3008, 9674 ± 3554, resp.). There were also no differences in daily distance traveled between baseline and HP and SM.
Protein Supplement Effect on Diet

Consuming a typical whey protein isolate supplement did not increase total protein intake. There was an increase in the proportion of energy consumed from protein but no increase in total energy. This increase in protein as a percent of TEI (with a lower TEI in HP than SM) and lack of change in absolute protein intake suggest there is a daily protein threshold that is required and individuals will consume nutrients to meet this. This whey protein supplement did not significantly change intakes of either fat or CHO but those consuming a standard meal supplement had a greater CHO consumption suggesting that equivalent supplements may have effects on CHO intake.

It has been suggested that there is an optimal daily protein intake which needs to be met (Tarnopolsky, 2010) and that this protein threshold is relative to lean muscle mass (Evans et al., 2012) and body fat mass (Vinknes et al., 2011), such that individuals with greater muscle and fat mass have a greater need for protein and a greater

Figure 2 — Daily macronutrient intake (g; mean ± SD) during baseline (n = 19) protein supplementation (HP; n = 19) and mixed macronutrient supplementation (SM; n = 18). †Carbohydrate intake significantly greater (p = .006) in SM than HP, linear mixed model ANOVA.

Table 3 Effect of High Protein (HP) and Mixed Macronutrient Standard Meal (SM) Supplementation on Energy and Protein Intakes (Mean ± SD) From Meals

<table>
<thead>
<tr>
<th></th>
<th>Baseline (n = 19)</th>
<th>HP (n = 19)</th>
<th>SM (n = 18)</th>
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</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy (kj)</td>
<td>2799 ± 1247</td>
<td>2301 ± 1010</td>
<td>3004 ± 1549</td>
</tr>
<tr>
<td>protein (g)</td>
<td>28 ± 16</td>
<td>25 ± 16</td>
<td>28 ± 11</td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy (kj)</td>
<td>2962 ± 1086</td>
<td>2906 ± 1008</td>
<td>3328 ± 1537</td>
</tr>
<tr>
<td>protein (g)</td>
<td>35 ± 17</td>
<td>36 ± 25</td>
<td>40 ± 21</td>
</tr>
<tr>
<td><strong>Dinner</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy (kj)</td>
<td>5896 ± 2775</td>
<td>4979 ± 2687</td>
<td>5224 ± 2022</td>
</tr>
<tr>
<td>protein (g)</td>
<td>74 ± 46</td>
<td>59 ± 36</td>
<td>66 ± 26</td>
</tr>
</tbody>
</table>

Note. No significant differences between groups.

(6.50 ± 2.86, 6.39 ± 2.45, 6.40 ± 1.96 km, resp.) or time spent in moderate to vigorous activity (40.47 ± 23.03, 41.39 ± 23.76, 46.95 ± 23.14, min, resp.).

**Discussion**

Consuming a typical whey protein isolate supplement did not increase total protein intake. There was an increase in the proportion of energy consumed from protein but no increase in total energy. This increase in protein as a percent of TEI (with a lower TEI in HP than SM) and lack of change in absolute protein intake suggest there is a daily protein threshold that is required and individuals will consume nutrients to meet this. This whey protein supplement did not significantly change intakes of either fat or CHO but those consuming a standard meal supplement had a greater CHO consumption suggesting that equivalent supplements may have effects on CHO intake.

It has been suggested that there is an optimal daily protein intake which needs to be met (Tarnopolsky, 2010) and that this protein threshold is relative to lean muscle mass (Evans et al., 2012) and body fat mass (Vinknes et al., 2011), such that individuals with greater muscle and fat mass have a greater need for protein and a greater
proportion of protein intake and lower energy intake, yet both conditions consumed a similar absolute amount of protein.

Total energy intake before supplementation (baseline) with HP and SM are in line with the average daily energy intake of New Zealand males between ages 18–30 of 10,380 kJ (University of Otago and Ministry of Health, 2011). Although there was some evidence of low energy reporting during the study, this existed on an individual level and was consistent during all phases of the study such that relative differences observed are considered valid.

The difference in energy intake between the two dietary interventions may be caused by several factors. Regulation of energy intake is complex involving biological, psychological and environmental factors (Leblanc et al., 2012; Rumpler et al., 2006). The current literature is not in agreement concerning the effects of protein supplements on total energy intake, especially with a wide variety of supplementing methods. The findings suggest that energy intake can be increased (Cawood et al., 2011; Kuipers et al., 1993; Neelamega et al., 2012; Raynaud-Simon, 2005; Wilson et al., 2002), decreased (Jeor et al., 2001) or unchanged (Rumpler et al., 2006) when supplementing with protein. It was concluded that the amount of protein (34 g) supplemented by Rumpler et al. (2006) was insufficient to induce a change in energy intake, which could explain why in this study there was no difference in energy intake between baseline and HP. Weight loss programs frequently promote diets high in protein content as an effective combatant to hunger in contrast to diets high in carbohydrate or fat due to greater satiety, however, much of the research on protein supplements and energy intake is based in populations with controlled energy intakes (El Khoury et al., 2010).

As previously mentioned there is evidence to suggest that animals eat to meet their protein needs. Although the majority of this evidence has come from nonhuman research, there is some support for control mechanisms relating to protein content of the diet in humans (Du et al., 2000; Webster, 1993). The potential satiating effect of protein compared with CHO and fat is one factor that may contribute to the decreased energy intake that is sometimes observed between those on higher versus lower protein containing diets (Latner & Schwartz, 1999; Rumpler et al., 2006). This may account for the difference observed in TEI between SM and HP. This observation is in agreement with Rolls et al. (1988) who detected a higher rating of fullness and lower rating of hunger after a preload of high protein compared with a pre load of high CHO, high fat, or mixed content. Stubbs and Tolkamp (2006) elaborate on this idea in their ecological model and hypothesize that the oxidation of protein may be responsible for the satiety effect via peripheral feedback, from oxidation of the predominant dietary macronutrient, which is sensed in higher centers. Oxidation of protein is indicative of a fed state and vice versa for fat; this would lead to high protein diets signaling a fed state, which may partially explain the decrease in energy intake between HP and SM.

Gut hormones can influence energy intake (Willbond & Doucet, 2011) and dietary intakes can influence their release. In particular the gut hormone ghrelin and its counterpart leptin have been shown to influence energy intake through alteration of hunger. Ghrelin, which is released

<table>
<thead>
<tr>
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<th>Baseline n = 19</th>
<th>HP n = 19</th>
<th>SM n = 18</th>
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<tbody>
<tr>
<td><strong>Protein (g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w/o supplement</td>
<td>131 ± 57</td>
<td>113 ± 56</td>
<td>130 ± 42</td>
</tr>
<tr>
<td>w/supplement</td>
<td>-</td>
<td>142 ± 56</td>
<td>141 ± 42</td>
</tr>
<tr>
<td>difference</td>
<td>-</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td><strong>Carbohydrate (g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w/o supplement</td>
<td>289 ± 115</td>
<td>259 ± 95</td>
<td>312 ± 135</td>
</tr>
<tr>
<td>w/supplement</td>
<td>-</td>
<td>272 ± 95</td>
<td>342 ± 135</td>
</tr>
<tr>
<td>difference</td>
<td>-</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td><strong>Fat (g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w/o supplement</td>
<td>105 ± 35</td>
<td>90 ± 36</td>
<td>101 ± 36</td>
</tr>
<tr>
<td>w/supplement</td>
<td>-</td>
<td>98 ± 36</td>
<td>111 ± 36</td>
</tr>
<tr>
<td>difference</td>
<td>-</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td><strong>Alcohol (g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w/o supplement</td>
<td>8.4 ± 14.0</td>
<td>4.8 ± 9.0</td>
<td>4.9 ± 11.0</td>
</tr>
<tr>
<td>w/supplement</td>
<td>-</td>
<td>4.8 ± 9.0</td>
<td>4.9 ± 11.07</td>
</tr>
<tr>
<td>difference</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
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</table>

*Note. No significant differences between groups.*
from adipose tissue, increases preprandially, and decreases postprandially (El Khoury et al., 2010). An increase causes greater hunger and a decrease satiation (Nakazato et al., 2001). El Khoury et al. (2010) observed that low carbohydrate meals, with a high protein content similar to that of the current study, led to long lasting decreased postprandial ghrelin concentration compared with a standard mixed macronutrient meal. This finding would suggest that ghrelin plays a role in reducing hunger with a high protein diet. This could contribute to the decreased energy intake observed during HP compared with SM.

The results of the current study, suggesting that a daily whey protein supplement increases proportional protein intake, in trained males, with no increase in energy or the absolute amount of protein consumed, could be counterproductive to athletes wanting to gain mass. It is unknown if maintenance of the supplementation for longer periods would result in similar results. It has been suggested that 2 weeks is the minimum for dietary behavior to adjust when individuals are introduced to an intervention (Rumpler et al., 2006). Due to absorption kinetics and digestion rates there may be variability in dietary intakes with differing protein sources, such as soy or casein (Pennings et al., 2011). It is also acknowledged that there is inherent error with any sort of diet recording, with participants potentially over-, and under-reporting intakes when completing weighed dietary records (Westerterp & Goris, 2002), particularly as we did not ask whether they were trying to gain or lose weight and participants could have potentially been restricting energy intake.

There was greater carbohydrate consumption with SM than HP (absolute and per kilogram body mass). The increased carbohydrate intake with SM can partly be explained by the increased carbohydrate content of the supplement. It could also be said that to meet daily needs of protein (Evans et al., 2012) the participants increased their total energy intake and gathered the majority of this from high carbohydrate sources, as there was no significant change in fat intake between groups. It also appears that by taking a high protein supplement compensation occurs such that less energy and protein are coming from other food sources and therefore micronutrient intakes may be altered.

Activity levels did not change throughout the trial period confirming that participants followed instruction not to alter activity levels and kept their training regimen the same as it was at baseline. The lack of difference in energy intake between both interventions and baseline is in line with the lack of change in activity levels between baseline and supplement periods and in body mass over each supplement period. Training regimen and timing thereof relative to regular meals were not controlled as the timing of supplementation was related to the training time and not in relation to regular meal time; any effect of the timing of the supplement on meal intakes is unknown.

In summary, neither energy intake nor total protein intake are increased when a whey protein supplement (29.6 g protein/day) is consumed, in addition to an ad libitum diet for 2 weeks, in normal weight, active, young males. When a mixed macronutrient supplement is given, however, the energy intake is greater than when a protein supplement is consumed. These findings have implications for athletes wanting to enhance protein availability and whether there is the desire to maintain, gain or lose body mass. To understand mechanisms resulting in the differential energy intake with supplements varying in protein content future research with measurements of satiation and gut regulating hormones would be valuable, with longer term interventions to fully evaluate adaptive responses.

**Acknowledgments**

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**References**


Institute of Medicine, Food and Nutrition Board (2005). *Dietary reference intakes for energy carbohydrate, fiber,


