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CURRENT OPINION

Should Competitive Bodybuilders Ingest More Protein than Current Evidence-Based Recommendations?

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Abstract

Bodybuilding is an aesthetic sport whereby competitors aspire to achieve a combination of high levels of muscularity combined with low levels of body fat. Protein is an important macronutrient for promoting muscle growth, and meeting daily needs is necessary to optimize the accretion of lean mass. Current recommendations for muscle hypertrophy suggest a relative protein intake ranging from 1.4 g/kg/day up to 2.0 g/kg/day is required for those involved in resistance training. However, research indicates that the actual ingestion of protein in competitive bodybuilders is usually greater than advocated in guidelines. The purpose of this current opinion article is to critically evaluate the evidence on whether higher intakes of protein are warranted in competitive bodybuilders. We conclude that competitive bodybuilders may benefit from consuming a higher protein intake than what is generally prescribed for recreationally trained lifters; however, the paucity of direct research in this population makes it difficult to draw strong conclusions on the topic.

Key Points

Bodybuilders may benefit from ingesting more daily protein than the current evidence-based recommendations.

There is some evidence indicating that a higher ingestion of protein (≥ 3.0 g/kg/day) enhances improvements in body composition.

There is a lack of direct data regarding protein ingestion in competitive bodybuilders, making specific recommendations speculative.

1 Introduction

Protein (PRO) is an important macronutrient for promoting muscle growth. Accordingly, meeting daily PRO needs is necessary for optimizing the accretion of lean mass [1–4]. Current evidence-based recommendations suggest a relative PRO intake ranging from 1.4 g/kg/day up to 2.0 g/kg/day for those involved in regimented resistance training (RT) with a goal to increase muscle mass [1, 3, 4]; based on prevailing evidence, consuming beyond this amount would not induce further hypertrophic benefits. However, underestimating PRO needs may impair a bodybuilder's ability to reach his maximum hypertrophic potential.

Research indicates that the actual ingestion of PRO in the competitive bodybuilder (BB) is usually greater than advocated in current guidelines [5, 6]. For example, Spendlove et al. [5] observed that average PRO intake of male BBs is 2.5 g/kg/day in the offseason, and 2.4 g/kg/day in the competition phase, reaching values as high as 4.3 g/kg/day. In contrast, carbohydrate intake in these athletes ranged from 243 g/day (3.0 g/kg/day) to 637 g/day (7.2 g/kg/day), while intake of dietary fat ranged from 19 g/day (8% of energy) to 241 g/day (33% of energy). As a general rule, consumption of carbohydrate and fat are the primary macronutrients targeted for reduction during the pre-competition period, with PRO intake tending to remain fairly constant. Given the contradiction between current evidence-based PRO

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recommendations and what BBs actually consume in practice, we can question whether BBs are misguided in their actions and simply "wasting" energy intake on superfluous PRO consumption (and thus potentially missing out on other important nutrients found in carbohydrate and/or fat), or if there is perhaps a viable rationale for the greater-than-recommended PRO intake in this population.

There is a relative paucity of research on daily PRO requirements in well-trained individuals, and to the authors' knowledge no study has investigated the topic in competitive BBs. Considering that competitive BBs have unique regimens of training, periodization, diet, and use of ergogenic aids, the results of previous research on the topic should be taken with a degree of caution when attempting to extrapolate recommendations to BBs. Thus, the purpose of this current opinion article is to critically evaluate the evidence on whether higher intakes of PRO are warranted in competitive BBs.

2 Current Evidence Regarding Protein Intake in Resistance-Trained Individuals

Only a few experiments have been conducted to determine optimal protein needs for muscle growth in resistance-trained individuals. Tarnopolsky et al. [7] investigated leucine kinetics, whole-body protein synthesis, and nitrogen balance (NB) in seven strength athletes who consumed higher (2.4 g/kg/day), moderate (1.40 g/kg/day), or low PRO (0.86 g/kg/day) under isocaloric conditions over a 13-day period. Results indicated that NB was greater for higher PRO intake (+3.8 N/day) compared to moderate PRO (+0.7 N/day), and the leucine oxidation was also greater for higher PRO intake condition; however, whole-body PRO synthesis was similar between conditions. Multiple linear regression analysis (with a safety margin of 1 standard deviation) of nitrogen intake revealed an estimated PRO requirement of 1.76 g/kg/day of PRO in this cohort of strength athletes.

Lemon et al. [8] investigated PRO requirements during the early stages of training in 12 detrained (for at least 1 year) men who received 2.62 g/kg/day or 1.35 g/kg/day of PRO while following an isoenergetic diet for 4 weeks. Results indicated that all subjects were in a negative NB during lower PRO. Overall, a greater NB was noted in the higher versus the lower PRO condition (8.9 N/day vs. −3.4 N/day, respectively). Although the higher PRO intake produced slightly greater gains in some measures, the differences between conditions was not significant from a probability standpoint for lean body mass gain (estimated by hydrostatic weighting) and for muscle hypertrophy of the midarm and midthigh (measured by computerized axial tomography). These findings indicate that during the early stages of reinitiating a RT program, there is no benefit to consuming very high amounts of PRO. Linear regression (with a margin of 2 standard deviations) from NB produced an estimated requirement of 1.6–1.7 g/kg/day for muscle hypertrophy.

It should be noted that estimation of PRO intake in the two aforementioned studies [7, 8] as well as the majority of studies used to make evidence-based recommendations on the topic is based on measures of NB, which theoretically provides insight into the net balance of protein synthesis and catabolism in the body. However, there are a number or concerns about the interpretation of NB studies that warrant caution when attempting to draw practical inferences [9–13]. For one, questions have been raised as to its ability to accurately estimate nitrogen losses through the skin, hair, nails, and bodily excretions; attempts to statistically correct for these losses have proven ineffectual [12]. For another, inherent large, between-subject variances in humans requires testing of the same participant over a range of test amino acid levels [11], a practice that generally is not undertaken. Moreover, linear regression analysis is generally employed to interpret data that are nonlinear by nature, potentially leading to inaccurate conclusions [14]. Due to these limitations, use of the NB balance technique may result in underestimation of optimal protein requirements [11].

A positive NB also does not necessarily translate into an increase in lean body mass. In the experiment by Lemon et al. [8], an increase in lean mass and hypertrophy of the biceps was noted even with subjects in a negative NB. This suggests that NB may lack validity as a method for inferring the effects of PRO intake on muscle hypertrophy. Also, Lemon et al. [8] observed hypertrophy only in the upper limbs, but no changes were detected in the thigh musculature. This raises the possibility that results may be dependent on the region of the body analyzed. Therefore, recommendations based on NB in providing determinations of physiological requirements for PRO intake should be viewed with some degree of circumspection.

Bandegan et al. [15] sought to quantify PRO requirements in eight resistance-trained individuals (with at least 3 years of RT experience) using the indicator amino acid oxidation technique—a method purported to have greater validity than NB for assessing PRO requirements [13]. Participants were considered to be near their maximal muscular potential, with all attaining a muscularity index of > 90% when compared to past Mr. USA winners (based on fat-free mass normalized to height). Over the span of several weeks, resting oxidation of L-[1-^{13}C] phenylalanine was measured for each subject on a non-training day in a series of PRO intakes ranging from 0.1 to 3.5 g/kg. PRO requirements were estimated to be 1.7 g/kg/day, with an upper 95% confidence interval of 2.2 g/kg/day. A potential issue with this experiment is that assessments were made on non-training days. It therefore is

not clear whether PRO requirements on training days may differ from the reported values.

Recommendations on the topic are generally based on data from acute investigations. Considering that acute findings do not necessarily reflect chronic adaptations, better insights may be gleaned from longitudinal studies of a medium- to long-term duration, whereby different amounts of PRO are consumed in conjunction with regimented RT. One such study by Hoffman et al. [16] investigated 23 collegiate strength/power athletes from the college's track and field team with at least 2 years of RT experience over the course of a 12-week RT program. Participants were stratified according to their self-reported habitual daily PRO consumption as follows: Below recommended levels (1.19 g/kg/day; $n=8$), recommended levels (1.74 g/kg/day; $n=7$), and above recommended levels (> 2.36 g/kg/day; $n=8$). Energy consumption was similar between groups across the study period. Results indicated no statistically significant between-group differences for changes in lean body mass (as determined by dual energy x-ray absorptiometry) from pre- to post-study; however, the higher PRO group achieved greater absolute increases in lean body mass than those consuming PRO at either recommended levels or below recommended levels (+ 1.10 kg, + 0.77 kg, and − 0.01 kg, respectively). The non-significant increase in lean mass may be related to the lower caloric intake of the participants (31.9–33.6 kcal/kg/day) compared to that habitually consumed by competitive BBs during a hypertrophy phase [5, 17], which averages ~ 46 kcal/kg/day [5]. Studies have shown that higher energy intakes induce greater increases in hypertrophy when compared to lower caloric conditions [18, 19]; therefore, the results may have been underestimated.

Although energy intake is an important determinant in the capacity to build muscle [20], it should be noted that bodybuilding is an aesthetic sport whereby competitors not only need to achieve high levels of muscularity, but need to do so in combination with very low levels of body fat [21]. This is problematic given that a positive energy balance is generally accompanied by an increased fat deposition, particularly in lean, well-trained individuals [19]. There is some evidence that consuming a higher PRO intake during a caloric surplus may induce positive alterations in body fat without compromising gains in lean mass [22, 23]. Antonio et al. [22] randomized forty-eight resistance-trained men and women to consume 2.3 or 3.4 g/kg/day of PRO in conjunction with a regimented RT program for 8 weeks. Results indicated that both groups increased lean mass (estimated by air displacement plethysmography) by ~ 1.5 kg with no observed between-group differences. However, the higher PRO group showed a greater decrease in fat mass compared to the normal PRO group (− 2.4% vs. − 0.6%, respectively), despite the fact that the higher PRO group consumed more calories (~ 400 kcals/day). Another 8-week study from the same lab [23] found subjects consuming an additional 800 kcal/day via a higher PRO intake (4.4 g/kg/day) showed similar changes in fat mass when compared to a group consuming a normal PRO intake (1.8 g/kg/day). Therefore, it can be inferred that PRO calories when consumed in excess are not metabolized by the body in the same manner as other macronutrients.

The theorized metabolic advantage from higher PRO intakes may be at least in part mediated by an increase in 24-h energy expenditure and sleep energy expenditure [24]. Hackney et al. [25] provided further support for this theory, observing greater increases in resting energy expenditure at 24 h post-exercise when resistance-trained individuals consumed an isocaloric bolus of PRO versus carbohydrate 20 min prior to an intense RT session. Taken together, results suggest that a higher PRO diet can be beneficial for BBs to optimize body composition during the offseason, as the strategy may help to prevent excessive fat gain without compromising muscular development.

In addition to an offseason phase designed for bulking, an important component of BB preparation generally involves a pre-contest phase, whereby the main objective is to reduce body fat levels while maintaining (or perhaps even slightly increasing) muscle mass. Consistent with the first law of thermodynamics, achieving a negative energy balance is necessary to reduce body fat levels [26], and this is most readily accomplished via dietary caloric restriction. However, restricting energy intake may also concomitantly reduce lean mass. Areta et al. [27] observed that during an energy-restricted condition a 30-g dose of PRO consumed after a RT bout induced a greater muscle protein synthesis response compared to a 15-g PRO dose (~ 34% vs. ~ 16%, respectively). Thus, adopting strategies that help to counteract muscle catabolism during the pre-contest phase is critical for success in the sport.

In this regard, several studies show that a higher PRO diet is more effective in sparing fat-free mass during diet-induced weight loss phase [28–33]. Mettler et al. [31] observed an attenuation in losses of lean body during a hypoenergetic weight loss protocol when consuming a higher compared to a lower PRO intake (~ 2.3 g/kg/day vs. ~ 1.0 g/kg/day). Results may be attributed to the ability of higher PRO to mitigate the decline in muscle PRO synthesis during periods of energy restriction [34]. Collectively, these findings suggest a benefit to creating an energy deficit by reducing carbohydrate and/or fat consumption while maintaining a high PRO intake during pre-contest preparation as a means to optimally reduce body fat levels while sparing lean mass.

Another important factor to be considered is that previous studies on the topic failed to take into account possible interactions between RT variables (i.e., volume, intensity, muscle action, movement speed, range of motion) and PRO intake with respect to effects on muscle hypertrophy. The volume

of RT is potentially of particular relevance. Specifically, it remains feasible that RT sessions with high volumes may require higher intakes of PRO to counteract increased PRO degradation and thus promote an anabolic environment. If such an interaction between RT volume and PRO intake does in fact exist, it would have important implications for BBs, as they are known to employ high volume training cycles [21]. An initial approach to test this hypothesis would be a short-term trial investigating the within-subject muscular PRO synthesis response after RT sessions employing differing levels of volume.

Moreover, the timing of PRO ingestion also should be taken into account. For example, an acute dose of 20 g of PRO every 3 h throughout a 12-h post-RT recovery period was found to be more effective than ingestion of 40 g every 6 h and 10 g every 1.5 h [35]. Given that amino acids are oxidized at an increased rate above a given threshold of protein intake, it is advisable for BBs to spread out consumption in multiple meals over the course of a day [36]. At a daily intake of 2.2 g/kg, this could be accomplished by consuming four approximately evenly spaced meals of 0.55 g/kg/meal; higher daily PRO intakes would seemingly necessitate greater meal frequencies to optimize amino acid utilization for tissue building purposes.

It also should be noted that no study to date has endeavored to investigate PRO needs in competitive BBs. The study by Bandegan et al. [15] employed resistance-trained men who were muscular, but no mention was made of whether the subjects actually participated in competition; it is not clear whether the rigors of pre-contest preparation may alter PRO needs. The sample in the Tarnopolsky et al. [7] study consisted of two football players and two rugby players who performed strength exercise for at least 2 months before the study, and three other participants who performed weightlifting exercises for 3 months before the study. Another study frequently cited as providing evidence for PRO requirements in BBs is the Lemon et al. [8] experiment; however, although the title of the paper states the sample consisted of "novice bodybuilders," participants actually had not performed any type of resistance exercise for at least 1 year. And while participants in the Hoffman et al. [16] study appear to be fairly well trained (collegiate footballers, sprinters, or throwers with at least 2 years of RT experience), none reported having previously competed in any bodybuilding event (amateur or professional). Therefore, the daily PRO requirement for bodybuilding competitive athletes remains unknown, and further study is needed to obtain better insights into the topic.

3 Conclusion

We conclude that competitive BBs may benefit from consuming a higher PRO intake than what is currently recommended for recreationally trained lifters; however, the paucity of direct research in this population makes it difficult to draw strong conclusions on the topic. Given the unique needs of competitive BBs, the optimal PRO intake for this population remains to be determined. In regard to maximizing muscle hypertrophy, it would seem prudent for BBs to consume at least 2.2 g/kg/day, as per the upper 95% confidence interval findings of Bandegan et al. [15]. At the very least, this recommendation provides a safety margin to help ensure a positive milieu for muscle-building; there is no apparent downside to consuming somewhat higher amounts of PRO from a muscle-building standpoint as any amino acids not used for anabolism are ultimately oxidized, thereby making for a favorable risk/reward ratio. It remains possible that a higher PRO intake may be beneficial during periods of very high-volume RT, although this hypothesis remains untested. Higher protein intakes during the pre-contest period appear warranted to help maintain muscle mass while losing body fat. Helms et al. [37] suggested an intake of 2.3–3.1 g/kg/day of lean body mass in lean, resistance-trained individuals in a caloric deficit; this recommendation needs confirmation in competitive BBs, but the upper range of these values may be considered a good target intake when energy restriction is implemented during the pre-contest phase. Finally, these recommendations pertain to drug-free bodybuilders; it is not clear whether, and to what extent, the use of anabolic agents may alter daily PRO requirements.

Compliance with Ethical Standards

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Conflict of interest Alex S. Ribeiro, João Pedro Nunes, and Brad J. Schoenfeld declare that they have no conflicts of interest that are relevant to the content of this article.

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