ALAN ARAGON'S RESEARCH REVIEW

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EDITOR'S CUT

Nutrient Timing, Part 1: Fat

By Alan Aragon

INTRODUCTION

In this nutrient timing series, I'll review the research on the macronutrients, then take a look at some of the relevant micronutrients and supplements. It's the very first issue, so I might as well open with the good stuff – *fat*. As much as I love protein and carbs, if I couldn't slather a certain amount of fat over them, they would fall short of glory.

Much of the existing sports nutrition research is done on endurance athletes, so a certain degree of extrapolation and assumption must be done by those attempting to apply the data to different activities.

HIERARCHY OF IMPORTANCE

When speaking of nutrition for improving body composition or athletic performance, it's crucial to realize there's an underlying hierarchy of importance. At the top of the hierarchy of effects is total amount of the macronutrients by the end of the day. Below that – and I mean *distantly* below that – is the precise timing of those nutrients. With very few exceptions (i.e., the intermittent fasting crowd), athletes and active individuals eat multiple times per day, to the tune of at least four meals. Thus, the majority of their day is spent in the postprandial (fed) rather than a post-absorptive (fasted) state. The vast majority of nutrient timing studies have been done on overnight-fasted subjects, which obviously limits the applicability of the studies' conclusions. Pre-exercise (and/or during-exercise) nutrient intake often has a lingering carry-over effect into the post-exercise period. Throughout the day, there's a constant overlap of meal absorption. For this reason, nutrient timing is not a strategy that's only effective if done with chronometer-like precision.

PRE-EXERCISE

The obvious objective of the pre-exercise meal is to increase exercise performance, whether it be endurance or strength, or a combination. The less visible objectives are to promote muscle protein synthesis and inhibit muscle protein breakdown – which I'll cover when we look at protein and carbohydrate timing in forthcoming articles.

Fat Loading

Pre-exercise fat intake in the literature thus far has concentrated on endurance goals. One of the primary objectives of nutrition prior to endurance training is to spare (minimize) the use of glycogen during the activity. An alternate tactic to the more famous *carb loading* used to maximize intramuscular fuel availability is *fat loading*, which originally involved 2-7 weeks of high fat intake. More recently, it has been tested in as little as 2-6 days of high fat intake (~60-70% of total kcals).[1-3] The potential performance benefit is the sparing of glycogen via increased intramuscular triacylglycerol oxidation during training.[4] Another potential positive is that this increased fat oxidation persists at rest, and can remain so despite a substantial influx of carbs.[5,6] The greater someone's activity and fitness level is, the faster these adaptations occur.[6]

Becoming "fat-adapted" from a steady high fat intake comes with the price of compromising glycogen storage. In recent attempts to remedy this problem and get the best of both worlds, a high-carb day was placed at the end of 5-6 high-fat days, but still failed to significantly improve performance.[1-3,7] Despite the lack of definitive evidence supporting it, a high-fat approach for endurance sports has been a provocative debate topic amongst the primary researchers themselves. To get a feel for the subtleties of the argument, I encourage you to read this letter by Noakes[8] in response to the conclusions of a trial by Carey and colleagues.[3]

In the latest trial to use this type of combination protocol, Havemann's team observed better sprinting performance after 6 days of 68% carbs than on 6 days of 68% fat prior to the carb-load day (8-10g/kg).[7] The sprints were interspersed at several points throughout a 100 km course, mimicking real-life competition conditions. In light of these findings, Burke and Kiens summarized the state of affairs as follows:[9]

"It is tempting to classify endurance and ultraendurance sports as submaximal exercise, which might benefit from increased fat utilization and a conservation of limited endogenous carbohydrate stores. However, the strategic activities that occur in such sports, the breakaway, the surge during an uphill stage, or the sprint to the finish line, are all dependent on the athlete's ability to work at high intensities. With growing evidence that this critical ability is impaired by dietary fat adaptation strategies and a failure to find clear evidence of benefits to prolonged exercise involving self-pacing, it seems that we are near to closing the door on one application of this dietary protocol."

Single Pre-loads Near Training

Medium-chain triacylglycerols (MCTs) are composed of fatty acids with a chain length of 6-12 carbons (some sources say 6-10). Unlike long-chain triacylglycerols (LCTs), MCTs bypass the lymphatic route and travel rapidly into portal circulation via passive diffusion, which make it a readily available energy source. Interest in the unique metabolism of MCT has spurred investigations into its effect on body composition and exercise performance. Contrary to marketing, MCTs' fat loss effects are not too impressive. For example, two 12-week trials showed a fat loss of 1.1-1.4 kg more than the control groups.[10,11]

How do MCTs hold up as a pre-exercise ergogenic? Jeukendrup and Aldred reviewed pre-exercise MCT research dating back to 1980.[12] Dosages ranged from 25-57g, taken 60 minutes prior to exercise at 60-84% VO_2max. Not only did MCT consistently fail to improve performance, it also did not prevent muscle glycogen breakdown.

As for speculation over the usefulness of pre-exercise LCT, Horowitz and Coyle compared 6 meals of varying fat content (up to 35% fat via the addition of margarine, with the exception of a Mars bar which was 35% fat on its own).[13] Each meal providing roughly 50g carbs was ingested 30 minutes prior to 60 minutes of cycling (30 minutes at 60% VO_2max, 15 minutes at 50% VO_2max, and finally 15 minutes at 70% VO_2max). Although exercise performance was not tested, no differences in perceived exertion were reported. Notably, this lack of difference in perception of fatigue included the overnight-fasted control group. It would have been nice to see a time trial in this study, but based on the available evidence, it's highly unlikely that the addition of LCT would improve performance.

One particular study has lead some folks to conclude that pre-workout fat hinders anabolism. Cappon and colleagues found that 57.7g fat consumed 45 minutes before a bout of high-intensity exercise elicited a 54 % reduction in post-exercise growth hormone than a noncaloric placebo.[14] On the other hand, 130g glucose lowered it 25%. There are a few problems with jumping to conclusions based on these results. First the obvious – 57.7g fat taken 45 minutes pre-workout, in isolation from the other macronutrients is extremely far-fetched. Something less glaring than that is the fact that glucose reached peak blood levels 30 minutes post-ingestion, so it was already on the decline at the 45 minute mark when exercise began. Had the glucose been consumed sooner to the training bout, we'd see lower GH values post-exercise.

Ultimately, while elevated GH is an anabolic when taken at supraphysiological doses or for correcting deficiency, it's also a compensatory response to inadequate nutrition or physiological stress. For example, hypoglycemia is a trigger of GH output, so is sleep deprivation, so is starvation. The rhetorical question is, which has a more powerful effect on gains in muscle – adequate food intake, or the rise in GH from a lack of food?

DURING EXERCISE

MCT is perhaps the most studied during-training fat. Once again, we must credit Jeukendrup and Aldred for reviewing the research dating back to 1995.[12] Doses ranged from 30-116g one hour prior to training, and at 15-minute intervals during training. Durations were 120-180 minutes, and intensity (excluding time trials) ranged from 57-60% VO_2max. Only one of the eight trials showed performance improvement and reduced glycogenolysis with MCT. Adverse gastrointestinal effects occurred in all subjects who consumed doses of 50g or more.

In more recent research, Goedecke's team had cyclists ingest either 32g MCT or 75g carbohydrate one hour prior to a five hour interval protocol ending in a time trial.[15] During exercise, 200ml of a 10% carbohydrate solution or one containing 4.3% MCT and 10% carbohydrate was consumed every 20 minutes. Performance was significantly worse in the MCT group, half of which experienced gastrointestinal upset. If anything can be said about MCT's track record – it's consistent.

POST-EXERCISE

Effect on 24-hr Glycogen Resynthesis

A common recommendation in sports and fitness circles is to avoid or minimize fat intake immediately after training, a time popularly called the "anabolic window" or "window of opportunity". The fear of post-exercise fat is based on its ability to slow gastric emptying, and thus slow the release of glucose into circulation which in turn reduces insulin response and glycogen resynthesis. Is this a valid concern? First of all, exercise can vary greatly in its ability to tap-out glycogen. Resistance training, as it's commonly done for strength, bodybuilding, or general fitness, is not glycogen-depleting in fed subjects on moderate-volume protocols. To illustrate this, Roy and Tarnopolsky observed 9 sets of 10 reps at 80% of 1 rep max to cause an average muscle glycogen decrease of 36%.[16] It's important to note that subjects consumed 3 mixed meals approximately 3 hours apart leading into the trial, which was 3 hours after their 3rd meal. A fasted scenario would have been more glycogen-depleting, as would a more voluminous protocol. The interesting find of this trial is that there was no difference in glycogen synthesis rate between a mixed post-workout drink (66% carb, 23% prot, 11% fat) and a 100% carb drink. Both drinks had the same proportion of carb types, so that potential confounder was controlled.

In another example of the triviality of worrying about fat's inhibition of glycogenesis, Burke's team compared a control diet of 7g/kg of high-GI carbs with two experimental treatments consisting of the control diet plus a substantial amount of added fat (1.6g/kg) and protein (1.2g/kg), and a matched-energy diet which was the control diet with added carbs to equal the calories of the experimental treatments.[17] Subjects trained for 2 hours at 75% VO2max, ending off the session with four 30-second sprints. Despite a high fat intake in the experimental group, no differences in muscle glycogen content were seen 24 hours after training compared to the low-fat groups.

Along these same lines, Fox and colleagues observed no difference in glycogen replenishment 24 hours after glycogen-depleting exercise despite the addition of 55g in the post-exercise meal and also in the two meals following it.[18] Think about it, 165g of additional fat did not prevent the resynthesis of identical amounts of glycogen the next day. And yes, carbohydrate content was the same in both diets. So, unless you've trained to depletion, and are going to train the exact same muscles in another exhaustive event within 24 hours, concerns of post-exercise fat getting in the way of glycogen resynthesis is just plain silly – especially if your total daily fat intake isn't stupendously high to begin with.

Recently, an online forumite posed an interesting question – should omega-3 fatty acids be avoided post-exercise due to their anti-inflammatory properties which could potentially hinder protein synthesis? As a corollary, should arachidonic acid's pro-inflammatory properties be taken advantage of at this time? While omega-3 fatty acids are anti-inflammatory, they're also vaso-dilatory (increasing blood flow). Incidentally, they're also broncho-dilatory (increasing breathing capacity). So, whatever detriment they might have near exercise is likely neutralized by other factors. As for arachidonic acid supplementation, a recent trial saw a *decrease* in the inflammatory effect of exercise.[19] Although it increased anaerobic sprint capacity, it had no effect on maximal strength or body composition.

Is It Necessary to "Spike" Insulin Post-workout?

Another concern of the fat-free-post-workout camp is the blunting of the insulin response. The rationale of maximizing the insulin response is to counteract the catabolic nature of the post-trained state, switching the hormonal milieu into an anabolic one, thus speeding recovery. Although this might benefit those who train fasted or semi-fasted, many don't realize that a pre-exercise meal (and in some cases the mid-exercise meal) is doing more than enough spiking of insulin levels for anticatabolic purposes.

It's an important objective to not only maximize muscle protein synthesis, but also minimize protein breakdown. However, the latter doesn't require a massive insulin spike, but rather just a touch beyond basal/resting levels. To illustrate this, Rennie & colleagues found that even during a sustained high blood level of amino acids, no further inhibition of muscle protein breakdown occurred beyond an insulin elevation to roughly 15 µU/mL,[20] which is slightly above normal basal levels of 5-10 µU/mL.

To reiterate, the pre-exercise meal can have profound effects on insulin levels that surpass the length of the training bout. Tipton's team found that as little as 6g essential amino acids + 35g sucrose taken immediately before exercise (45-50 minutes of resistance training) was enough to keep insulin elevated to roughly 4x above fasting levels 1-hour post-exercise.[21] It took 2 hours post-exercise for insulin to return to resting levels. A similar insulin response was seen with 20g whey by itself taken immediately preworkout.[22] If carbs were added to the pre-training protein, there would be yet a greater insulin response.

As far as solid food goes, Capaldo's team examined various metabolic effects during a five hour period after ingesting a meal composed of 75g carb (47%), 37g prot (26%), and 17g fat (27%).[23] Although this study didn't examine training effects, this meal would make a nice post-workout meal due to its absolute (and proportional) amounts of protein and carbohydrate. The fat-fearing camp would warn against the meal's fat content interfering with the insulin response. However, this meal was able to raise insulin 3 times above fasting levels within 30 minutes of consumption. At the 60 minute mark, insulin was 5 times greater than fasting. At the 300 minute mark, insulin levels were still double the fasting level.

Elliot and colleagues compared the effect of fat-free milk, whole milk, and a higher dose of fat-free milk (to match the calories of the whole milk) taken 60 minutes post-resistance exercise.[24] Whole milk was superior for increasing net protein balance. Interestingly, the calorie-matched dose of fat free milk containing 14.5g protein, versus 8.0g in the whole milk (an 81% advantage), but still got beaten. The investigators speculated over the possible mechanisms behind the outcome (insulin response, blood flow, subject response differences, fat content improving nitrogen retention), but end up dismissing each one in favor of concluding that further research is necessary to see if extra fat calories ingested with an amino acid source will increase muscle protein synthesis. Lingering questions notwithstanding, post-workout milkfat was the factor that clinched the victory – at least in overnight-fasted subjects.

To put another nail in the coffin of the insulin spiking objective, post-exercise glycogen resynthesis is biphasic.[25] Unlike the subsequent "slow" phase which can last several hours, the initial "rapid" phase of glycogenesis lasting 30-60 minutes immediately post-exercise is not dependent upon insulin. Maximizing post-workout hyperinsulinemia may be beneficial for athletes with more than a single exhaustive endurance-containing training bout separated by less than approximately 8 hours, but in all other cases, the benefit in "spiking" insulin is nil.

In line with this theme, interesting research has surfaced in recent years challenging the idea that highly glycemic (and thus insulinemic) carbohydrates taken post-workout are the optimal for recovery. Erith's team found no difference between post-exercise high- and low-glycemic index (GI) carbohydrate intake on exercise performance the following day.[26] In a similar study, Stevenson's team actually saw better next-day performance in subjects who consumed low-GI post-exercise carbohydrate than those who consumed high-GI post-exercise carbohydrate.[27]

SUMMARY & APPLICATION

Hierarchy of importance, fat loading

- Of primary importance is total amount of the macronutrients by the end of the day. Timing of nutrients is secondary, since there's typically a constant absorptive overlap between meals in a well-constructed diet.
- Much of the existing sports nutrition research is done on endurance athletes, so an inevitable degree of extrapolation is necessary for those involved with non-endurance activities.
- 2-6 days of high fat intake (~60-70% of total kcals) can result in "fat adaptation", a state increased fat oxidation during training, and in conditioned individuals, at rest as well.
- Becoming "fat adapted" offers little to no ergogenic benefit. Adding a final-day-day carb load to a fat loading phase hasn't proven to remedy its lack of performance effect.
- Impaired sprinting ability resulting from fat loading carries negative implications for its utility in competitive endurance and ultra-endurance events, since they include intermittent bouts of increased intensity. Fat loading carries more risk than benefit, and can safely be avoided.

Single pre-loads

- MCT preloads do not increase performance or decrease glycogen breakdown during training. The scant data on LCT preloads indicate the same lack of benefit.

During exercise

- During exercise, MCT doesn't enhance performance, and can cause gastrointestinal upset, decreasing performance. For these reasons, LCT and MCT can safely be nixed.

Post-exercise

- Preliminary evidence suggests the potential for arachidonic acid to enhance anaerobic capacity (sprints in particular). However, it had no effect on strength or body composition.

- High amounts of post-exercise fat (up to approximately 165g) do not reduce 24-hour glycogen synthesis. Thus, those who do not train the same muscles to glycogen depletion (or near-depletion) more than once a day shouldn't be concerned with a normal fat intake, even in the post-workout period.

Is spiking insulin necessary post-workout? Generally not.

- No greater inhibition of muscle protein breakdown has been seen beyond insulin elevation to approximately 15 µU/l, which is slightly above resting/basal levels of 5-10 µU/l.
- In one study, whole milk was superior for increasing net protein balance post-workout, despite the calorie-matched dose of fat free milk containing 81% more protein.
- The initial 30-60 minute "rapid" phase of glycogenesis immediately post-exercise is not dependent upon insulin.
- There's no need to attempt to spike insulin for recovery purposes since maximal effects are seen at minimal elevations. Simply getting enough total substrate surrounding the training bout suffices, at least within the context of a 24-hour separation between exhaustive training of the same muscles. Multiple depleting endurance-type bouts per day (i.e., $\leq$ 8 hours between bouts) may be the exception to this rule.
- On a related tangent, it's been commonly recommended to maximize post-exercise hyperglycemia and hyperinsulinemia by consuming high-GI carbohydrates. However, this strategy has been seen to offer no benefit on next-day performance, and one recent study even saw endurance impairment.

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NUTRITION & EXERCISE

Smeets AJ, Westerterp-Plantenga. Acute effects on metabolism and appetite profile of one meal difference in the lower range of meal frequency. Br J **Nutr. 2007 Dec 6:1-6. [Medline]**

PURPOSE: To study the effect of the inter-meal interval by dividing energy intake over two or three meals on energy expenditure, substrate oxidation and 24 h satiety. **METHODS:** In a crossover design, 14 normal-weight women (mean age = 24.4 years), underwent two separate 36-hour sessions in energy balance in a respiration chamber. The subjects were given two (breakfast, dinner) or three (breakfast, lunch, dinner) meals per day. Appetite, energy expenditure, and substrate oxidation were assessed. **RESULTS:** Eating 3 versus 2 meals had no effects on 24-hr energy expenditure, diet-induced thermogenesis, activity-induced energy expenditure and sleeping metabolic rate. Eating 3 meals increased 24 h fat oxidation, but decreased the amount of fat oxidised from the breakfast. The same amount of energy divided over three meals compared with over two meals increased satiety feelings over 24 h. **CONCLUSION:** In healthy, normal-weight women, decreasing the inter-meal interval sustains satiety, particularly during the day, and sustains fat oxidation, particularly during the night. **SPONSORSHIP:** Top Institute Food and Nutrition, Wageningen, The Netherlands.

Study Strengths

The 'wash-out' duration between the treatments was 4 weeks to control potential variations at different points in the menstrual cycle. The maintenance-targeted dietary protocol was well controlled. During the 3 days prior to the trial, the lab provided take-home meals. Meals were lab-provided during the 36-hour trial as well. The tests took place in a respiration chamber containing all the essentials, plus a TV, radio, and a computer. Bedtime in the chamber was standardized. All subjects had a habitual frequency of at least 3 meals per day.

Study Limitations

Acute studies, by definition, are limited to the assessment of short-term effects. Who knows whether skipping lunch and compensating at dinner would play out to be a bad thing; only a chronic-effect trial could begin to tell us. This study, like many, is limited by the absence of a supervised, structured exercise program. The timing of nutrient blood levels relative to exercise can influence a number of outcomes, such as performance, muscle protein synthesis and muscle protein breakdown. As it stands, we can only interpret the present study's findings within the context of sedentary conditions.

Comment & Application

Respiratory quotient (RQ) is determined dividing the amount of carbon dioxide produced by the amount of oxygen consumed. A higher RQ indicates a greater oxidation of carbohydrate, whereas a lower RQ indicates a greater oxidation of fat. The 3-meal condition had a lower 24-hour RQ, thus showing a greater 24-hour fat oxidation than the 2-meal treatment. Accounting for protein metabolism was determined via non-protein respiratory quotient (NPRQ), which also was lower in the 3-meal group, again indicating more 24-hour fat oxidation than the 2-meal group. This lead the authors to conclude that *"a low meal frequency could be detrimental because it may reduce fat oxidation, due to the postponed fat oxidation after a high carbohydrate load, and promote fat storage due to the lower ability to compensate for fat intake."*

As seen repeatedly in previous research using metabolic chambers, there were no differences in diet-induced thermogenesis (DIT) between the treatments. Once again, the higher meal frequency didn't do its fabled job of "stoking the metabolism". Furthermore, While RQ indicated a higher 24-hr fat oxidation in the 3-meal treatment, it actually failed to impact fat balance as determined by deuterium-labeled palmitic acid (a method of tracking the metabolic fate of fatty acids). That is, the amount of fat oxidized ultimately was not greater than the amount of fat ingested in either group. In the 2-meal condition, skipping lunch created a fasting phase between breakfast and dinner, which lead the body to oxidize more fat from the breakfast instead of storing it, which was balanced out by an opposite effect from the large dinner.

As expected, 24-hour satiety was higher with the higher meal frequency. This effect was anticipated by the investigators, who suggest that meal frequency can have a regulatory influence on gut-derived hormones. They suggest that more frequent exposures to nutrients may lead to a "build up" of hormones associated with hunger suppression, such as glucagon-like peptide-1 (GLP-1). Previous unpublished work from their lab show increased GLP-1 concentrations after multiple exposures compared with one exposure, furthering the case for increased meal frequency as a tool for controlling appetite. The interactive effect of exercise and meal frequency on satiety is an untapped area of study.

Lyle McDonald, a fellow member of OA (Overthinkers Anonymous), addresses a very interesting question in his Protein Book: Can meal frequency be too high? Acknowledging its limitations, McDonald cites research suggesting an upper threshold of benefit, beyond which diminishing returns are seen. A study by Bohe et al observed the effect of a continuous intravenous elevation of mixed amino acids on muscle protein synthesis (MPS). Despite the rapid effect you'd expect from amino acids administered directly into circulation, it took 30 minutes for any measurable MPS to occur. But the most interesting finding was that after peaking at 2.8 times greater than basal (fasting) levels for 90 minutes, MPS fell to levels not significantly different from baseline for the remaining 4 hours of the trial. Keep in mind that this decrease back to baseline occurred despite the infusion maintaining blood amino acids at 70% above basal levels.

In a later study by the same researchers, a dose-response relationship was found using 4 escalating rates of amino acid infusion. MPS was greatest at the two middle treatments (87 and 162 mg/kg/hr, respectively), whereas it slightly diminished at the highest rate of infusion (261 mg/kg/hr). Thus, they hypothesize that the mechanism of MPS is based on an extracellular 'sensor' that not only regulates the rate of protein synthesis, but inhibits synthesis once a "muscle full" state is 'sensed'. At the close of the paper, the authors' calculations indicate that a protein intake of 30-40g per day is all that's required for achieving maximal stimulation of muscle anabolism. However, current reviews (and abundant empirical data) disagree, suggesting that at least 3-4 times this much is optimal for most athletic goals.

Strasser B, et al. Fat loss depends on energy deficit only, independently of the method for weight loss. Ann Nutr Metab. 2007;51(5):428-32. [Medline]

PURPOSE: To compare 2 different fat reduction programs with the same amount of energy deficit - diet alone or diet combined with aerobic training - on body composition, lipid profile and cardiorespiratory fitness. **METHODS:** 20 non- and moderately obese females (mean age = 27.3 years) underwent 8 weeks of a mildly hypocaloric diet. Subjects were assigned to either a diet alone (D) with a 400 kcal/day deficit, or diet plus exercise (DE). The energy deficit assigned to DE was 200 kcal/day from diet and 200 kcal/day (average) from exercise, accomplished by three 60-min sessions per week at 60% of VO2max. **RESULTS:** Actual deficits ended up being appx 100 kcal greater than assigned, with no significant differences between groups. Body mass & body fat decreased significantly in D (-1.95 kg) and DE (-2.23 kg), with no significant differences. No significant changes of total cholesterol, HDL-C, LDL-C, triacylglycerol, and heart rate were seen. Lactic acid accumulation during submaximal exertion decreased significantly in DE and increased significantly in D. Maximum exercise performance improved significantly in DE but not in D. **CONCLUSIONS:** Regardless of method, a negative energy balance alone is responsible for weight reduction. **SPONSORSHIP:** Not stated, email response from authors is pending.

Study Strengths

Perhaps the strongest aspect of this study had little to do with its design, but rather with its concept. The question of, "Is a deficit a deficit?" has been around for ages, yet very little investigation has been done to answer it. Subjects were instructed on portion size awareness, and an attempt was made to enforce compliance by random weekly 24-hour recalls.

Study Limitations

There was no specific breakdown of the number of moderately obese subjects and non-obese subjects. Also, no mention was made about the habitual exercise levels of the subjects. This matters because the two groups could potentially have markedly different responses to protocol, given good compliance. Obese individuals, especially those with a longstanding sedentary history, would likely be more responsive to either protocol (with little to no difference between groups) than non-obese regular exercisers. Another questionable aspect was the use of bioelectrical impedance (BIA) to measure bodyfat, given its inferiority to other methods such as hydrodensitometry and DEXA. The particular instrument used in this study was the Omron BF 302, a hand-held device you can buy for about 20 bucks. I own the predecessor to this model, the Omron HBF 301. It's a hand-held device as well, appearing nearly identical except for a slight difference in the layout of the input buttons. My Omron has been sitting unused in a file cabinet here in my office for years now. I discontinued it due to its inconsistency.

Comment & Application

In the spirit of this review, I pulled my BIA device out of storage. Just for experimentation, I took 2 measurements, one where I input my real stats, and one with added height. Keeping the weight constant but adjusting my height up 3 inches 'reduced' my bodyfat by 4%. Awesome.

So how does BIA validity stack up in the scientific literature? Recent research by Varady et al tested the validity of the hand-held BIA on overweight women by comparing it to magnetic resonance imaging (MRI). BIA was found to be highly reproducible, but it underestimated bodyfat percent by approximately 5.6%, at least in this population. A common criticism of BIA is its ability to be altered by hydration levels. However, a less-known confounder of BIA is the effect of food in general, rather than hydration per se. A study by Slinde's team used BIA to assess bodyfat 18 times in 24 hours, and came up with some interesting stuff. The lowest bodyfat reading was observed at 195 min after dinner for the women and at 125 minutes after lunch for the men. The difference between the highest and lowest readings was 2.3% for the women and 1.7% for the men. Taking this into consideration, we can only hope that all of the subjects had their body composition measured fasted in the morning, since digesting food lowers the reading.

The title of this study and the conclusion in the abstract might mislead some to think that diet alone has identical benefits to diet plus exercise. Well, that might have been expected given the meager, vaguely defined, one-dimensional training program, which was 60 minutes of either walking or running (depending on subject's physical limitations) done 3 times per week. Interestingly, this half-cocked exercise regimen measurably improved cardio-respiratory fitness, but it didn't improve blood lipids. This didn't surprise the authors of the present study, who referenced a 2001 review that agreed with this finding. However, several more recent meta-analyses by Kelley et al suggest that the findings of the present study are in the minority.

It's also possible that the lack of improvement in blood lipids in this trial was due to insufficient training volume. A quantitative analysis by Durstine et al suggests that exercise can potentially improve blood lipids at low training volumes, but the effects might not be seen until certain expenditure thresholds are met (at least 1200-2200 kcal/week). In the present trial, Subjects in the diet & exercise group had a weekly expenditure of roughly 1400 kcal, which is near the lower end of the effective range.

And what about the lack of difference in fat reduction between the groups? We've established that BIA was a poor choice for assessment, but earlier research using hydrodensitometry didn't show any additional fat loss from exercise (strength and/or cardio-respiratory training) compared to calorie reduction alone. In contrast, a similar study on men showed what would seem to be a no-brainer. Diet plus resistance & cardio training caused markedly greater fat loss over the two other treatments, diet-only and diet plus cardio. This difference between sexes could have been due to a number of variables, but interestingly, subjects in both trials were assigned insufficient protein intakes (0.6g/kg), falling short of the RDA of 0.8g/kg. It's possible that such glaring methodological flaws might be keeping the research inconsistent with what I've seen with fat loss clients of both sexes: calorie reduction alone is inferior to calorie reduction plus exercise that supports the retention of muscle mass.

Carlson O, et al. Impact of reduced meal frequency without caloric restriction on glucose regulation in healthy, normal-weight middle-aged men and women. Metabolism. 2007 Dec;56(12):1729-34. [Medline]

PURPOSE: To determine how changes in meal frequency without a reduction in energy intake affect energy metabolism. **METHODS:** Normal-weight, healthy middle-aged subjects (10 women, 5 men) underwent two 8-week treatment periods in a crossover separated by an 11-week washout period. Subjects consumed all of their calories for weight maintenance distributed in either 3 meals or 1 meal per day (between 4:00 pm and 8:00 pm). Energy metabolism was evaluated via morning oral glucose tolerance tests (OGTT) and measurements of brain-derived neurotrophic factor (BDNF), glucose, insulin, glucagon, leptin, ghrelin, adiponectin, and resistin. **RESULTS:** Subjects consuming 1 meal per day had higher fasting plasma glucose levels, greater and more sustained glucose elevation, and a delayed insulin response in the OGTT. Levels of ghrelin were elevated in response to the 1-meal-per-day regimen. Fasting levels of insulin, leptin, ghrelin, adiponectin, resistin, and BDNF were not significantly affected by meal frequency. **CONCLUSION:** A single large daily meal exhibit elevated fasting glucose levels and impaired morning glucose tolerance associated with a delayed insulin response compared with 3 meals per day. **SPONSORSHIP:** Intramural Research Program of the National Institute on Aging (Baltimore, MD).

Study Strengths

Meal frequency's effect on several energy metabolism-regulating adipokines were measured in addition to the standard parameters of insulin and glucose. Unlike this study's predecessor which did not standardize the time of day of the physiological assessments, this trial kept the bloodwork confined to the overnight fasted state in both treatments. A lengthy off-diet washout period (11 weeks) between crossover treatments sufficiently minimized the possibility of carry-over effects. As an added measure of control, energy intake was adjusted throughout the study to ensure bodyweight maintenance.

Study Limitations

No structured/supervised exercise program was administered. This common research limitation in diet research leaves plenty of open questions. But as seen in recent trial I discuss in this issue, the impact of exercise (versus caloric restriction alone) on bodyfat reduction is still a topic of debate. Speaking of limitations, instead of showing the details of the dietary treatments, the authors mistakenly reference a study on overweight asthmatics on an alternate-day ad-libitium diet interspersed with controlled calorie reduction days. It's safe to assume that the subjects were on the protocol of the previous "1 meal vs. 3 meals/day" study by many of the same investigators. Here's diet for your convenience: Only differing in meal frequency (1/day vs. 3/day), a weight maintenance diet averaging at 2396.5 kcal containing 49.4% carbohydrate, 14.6% protein, and 36% fat was consumed during both treatments. Without having the aforementioned diet details on hand, the reader is left in the lurch.

Comment & Application

Given the carbohydrate content of the diet (296g), it's not too surprising that the 1/day group had higher morning plasma glucose levels. This was somewhat predictable, since they consumed all of their day's intake within a four-hour time period the night before testing. No significant differences were seen in fasting plasma insulin levels. Oral glucose insulin sensitivity (OGIS) as well as first-phase beta cell function was lower in the 1/day treatment. But as noted, this could also have been a result of the huge night meal's residual influence on morning values, and not necessarily an actual chronic impairment in insulin sensitivity. Delaying the tests in the 1/day group by a few hours (or taking additional tests) could have cleared up this confounder. As is, the results remain in a state of "what if".

Increased fasting leptin, insulin, and glucagon are elevated in individuals with impaired glucose tolerance, but no such elevations were seen as a result of reduced meal frequency. Additionally, there was no significant effect of the single meal treatment on adipokines and grhelin. These findings contribute to the weakening of the case that a grazing pattern is necessary.

The authors are rather gentle with their conclusion: *"Collectively, the available data therefore suggest that meal skipping or intermittent CR diets can result in health benefits including improved glucose regulation, but only if there is an overall reduction in energy intake"* This quote came right after mentioning the benefits seen in an alternate-day calorie restriction trial without a control group. A more objective conclusion would reiterate that a single-meal protocol for weight maintenance has potentially adverse effects on insulin sensitivity and glucose tolerance. To date, no head-to-head comparisons of differing meal frequencies indicate the superiority of lower frequency for improving human health. Those interested in further review on meal frequency and intermittent fasting, I co-wrote an article with Ryan Zielonka here. Clearly, further investigation is warranted before singing the praises of the one-meal-wonder diet.

Exercise is known to share common effects with meal frequency reduction and/or caloric restriction, so it would be interesting to see how it would affect the outcomes. My hunch is, depending on the nature (and placement) of the exercise, it would greatly reduce or eliminate the differences seen in this study, especially under maintenance calories, and certainly under a caloric deficit.

Meal frequency is highly subject to personal preference and tolerance – not to mention individual work or lifestyle schedule – which varies widely. Practically speaking, most athletes with massive energy demands will not do well stuffing down 4000-6000 kcals over the course of anything less than 5-6 meals per day. Conversely, restricting calories for the goal of weight loss can done safely and effectively by reducing the number of meals, granted that no hypoglycemic tendencies will sabotage the effort. In general, athletes and active folks tend to do well on a minimum of 4 meals per training day. This allows a pre- (or mid-) and post-exercise meal, and two "floating" meals (and/or snacks) to be consumed where needed. Days off from exercise leave more room for meal frequency reduction if desired.

Stephens BR, et al. Effect of timing of energy and carbohydrate replacement on post-exercise insulin action. Appl Physiol Nutr Metab. 2007 Dec;32(6):1139-47. [Medline]

OBJECTIVE: To determine how timing energy and carbohydrate replacement relative to an exercise bout influences exercise-enhanced insulin action. **METHODS:** Insulin sensitivity was reduced in 9 healthy subjects (mean age = 30.2 yrs) by 2 inactive days of energy surplus. In a crossover fashion, insulin action was assessed during a continuous glucose infusion 12 hrs after a standardized meal under 4 conditions. In 3 conditions, the meal replaced the energy and carbohydrate expended during a glycogen-depleting exercise bout. The meal was given before (Pre), immediately after (ImmPost), or 3 h after exercise (Delay). The 4th condition was a no-exercise control (Control). **RESULTS:** Relative to Control, insulin action increased by 22% in Pre, 44% in ImmPost, and 19% in Delay. Non-oxidative disposal was higher, and oxidative disposal was lower in ImmPost compared to Control and Pre. Hepatic glucose production was suppressed by the infusion to a greater extent in Pre and Delay compared with ImmPost. **CONCLUSIONS:** A bout of exercise enhances insulin action even when expended energy and carbohydrate are replaced. Further, timing of energy and carbohydrate consumption can influence the effectiveness of exercise to enhance insulin action. **SPONSORSHIP:** American Diabetes Association Junior Faculty grant No. 7-04-Jf-10.

Study Strengths

Body composition was measured by dual energy X-ray absorptiometry (DEXA), which is widely considered the gold standard of assessment methods. Subjects had a historical exercise volume of more than 5 hours per week, eliminating the "everything works for deconditioned newbies" factor.

Sedentary, insulin-resistant, overweight individuals would benefit most from the intervention in this study. However, as the authors pointed out, this population isn't necessarily capable of completing the intense, glycogen-depleting exercise required in the protocol. In a creative way to solve this dilemma, the investigators recruited healthy, normal-weight, physically active subjects and induced a temporary reduction of insulin sensitivity by 25-30%. This was accomplished by having them cease exercise for 3 days, during which time they consumed 500 kcal above their maintenance energy requirements.

Study Limitations

Paradoxically, the above listed study strength can also be viewed as a major limitation, at least as far as broad applicability is concerned. Although using healthy subjects reduces the confounding effects of underlying disease, it still leaves unanswered questions about how differently subjects with the metabolic syndrome might respond to the experimental treatments. The authors themselves mention that lean, healthy subjects put into a temporary state of insulin insensitivity still retain a high level of "metabolic flexibility" that can potentially be reversed by a single bout of exercise. In contrast, those with long-standing metabolic impairments may less responsive to the beneficial effect of exercise on insulin action. This can possibly be resolved by putting overweight insulin-resistant subjects on an exercise regime less intensive/inherently risky (for this population anyway) than the glycogen depletion protocol used in the present study.

Comment & Application

The most important finding of this study was that a sizable meal (144g carb, 30g prot, 24g fat) immediately post-workout did not interfere with the insulin-sensitizing effects of exercise. In fact it actually *enhanced* the ability of exercise to exert its favorable effects on insulin action. In other words, compared to 3 other conditions (non-exercise control, pre-exercise meal, post-exercise meal delayed by 3 hours), the immediate post-exercise meal caused the greatest glucose uptake with the least amount of insulin output. This is striking, considering that the meal was designed to restore energy balance, replacing approximately 900 kcal burned as a result of exercise. One could dispute these results by citing opposite effects seen in a previous trial. Black et al compared the effect of post-exercise calorie replacement (restoring calorie balance) with no replacement (which created a negative energy balance). Neglecting to replace calories post-exercise enhanced insulin action, whereas having the post-exercise meal caused no change in insulin action.

But hold on – a closer look reveals 3 plausible explanations for the discrepancies between these study outcomes. First off, the subject profile and exercise protocols were different. Black et al put sedentary, obese/overweight subjects on a walking regimen that burned roughly 500 kcals per session, whereas the study we're currently examining used lean active subjects and put them through a 900 kcal-burning glycogen depletion protocol that involved moderate steady-state cardio followed by consecutive sprint sets. The second critical difference between the trials was the composition of the post-exercise meals. Black et al administered a meal containing 75% carb, 13% prot, and 12% fat, whereas the present study used a higher proportion of fat and lower proportion of carbohydrate (63% carb, 13% prot, 24% fat). Given these differences, it's reasonable to assume that overweight insulin-resistant subjects would exhibit more favorable insulin effects with the macronutrient breakdown of the aforementioned meal used in the present study. Finally, exercise of a greater magnitude than walking would have further enhanced insulin action.

Back to our study, the immediate post-exercise meal showed a key benefit in addition to enhanced insulin sensitivity. As would be expected, it was "partitioned" better than the both the pre-exercise meal and the 3-hour delayed post-exercise meal, evidenced by a higher oxidative and non-oxidative glucose disposal. In plain terms, this means that compared to the other meal conditions, more of its glucose content was taken up and utilized by muscle tissue. This carries important implications for body composition goals, where the objective is to position calorie intake to maximally benefit muscular demands. In future research, I'd like to see a pre+post-exercise meal treatment included for comparison in a similar protocol carried over several weeks, incorporating a structured resistance training protocol. I realize that this may be too much to ask.

SUPPLEMENTATION

Roberts MD, et al. Effects of ingesting JavaFit Energy Extreme functional coffee on aerobic and anaerobic fitness markers in recreationally-active coffee consumers. J Int Soc Sports Nutr. 2007 Dec 8;4(1):25. [Medline]

PURPOSE: To examine the effects of ingesting JavaFit Energy Extreme (JEE) on aerobic and anaerobic performance measures in recreationally-active male and female coffee drinkers. **METHODS:** In a cross-over design, ten 27-29 yr-old regular coffee drinkers performed a set of baseline tests: a graded treadmill test (GXT) for peak VO2 assessment, and a Wingate test for peak power. 3-4 days following baseline testing, subjects returned for the first trial and ingested 354ml of either JEE or decaffeinated coffee (DECAF), then performed a GXT and Wingate test. During the GXT, peakVO2 at maximal exercise, and VO2 at 3 minutes and 10 minutes post-exercise were assessed. Time-to-exhaustion (TTE), maximal rate of perceived exertion (RPE), mean heart rate (HR), mean systolic pressure (SBP), and mean diastolic blood pressure (DBP) were measured during each condition. Wingate measures included HR, SBP, DBP, peak power, and time to peak power (TTP). About 1 week later, subjects performed the second trial under the same conditions, except using decaf coffee. **RESULTS:** The JEE significantly increased VO2 at 3 minutes post-exercise when compared to baseline and DECAF values. **CONCLUSION:** JEE may be beneficial in enhancing post-exercise fat metabolism. **SPONSORSHIP:** Javalution Coffee Company (Ft Lauderdale, FL), via an unrestricted research grant from Baylor University.

Study Strengths

Recognizing that habitual coffee drinkers may build a degree of tolerance to the stimulant effects of caffeine, regular coffee drinkers were used here. Self-reported intake averaged at 223.9mg/day, the equivalent of 2-3 cups of coffee. As an extra measure of control, subjects were instructed to consume no less than one cup of coffee per day during the week prior to the trial. Subjects were required to keep 24 dietary records prior to each trial, and nutritional software was used to insure caloric consistency between trials.

Study limitations

This was a *single-blind* trial, meaning the subjects were unaware of which treatment was the experimental one, and which was the placebo – but the investigators were fully aware. This opens the possibility for bias, and it baffles me why they wouldn't take the extra step to make it a *double-blind* trial. Another glaring weakness in this study is the comparison of a caffeine-fortified regular coffee to a decaffeinated one. If the value of the product is based on its effects beyond regular run-of-the-mill coffee, whose active agent is its caffeine, then why remove it from the control group? This is a true head scratcher. If Javafit Energy Extreme was compared to a popular brand of regular (non-decaf) coffee, then the investigators would have something to write home about.

Comment & Application

On the company website, Javafit Energy Extreme contains a different set of compounds than the product examined in this trial. Instead, a variation called Javafit Diet Plus matches the fortification of the product used here. A serving (1 tablespoon; 4.5g ground coffee) has 670mg of a proprietary blend containing 75mcg chromium polynicotinate and 150mg caffeine. This leaves roughly 520mg of the herbs garcinia cambogia and citrus aurantium.

Do these compounds have sufficient scientific support? Caffeine is proven, the rest are questionable. For example, the authors cite rodent research to support chromium polynicotinate's hypotensive and antioxidant effects. Chromium supplementation has consistently failed in human research for improving body composition. Garcinia cambogia is an herbal extract containing hydroxycitric acid (HCA), which is hyped to aid weight loss. Once again, the authors cite rodent research to justify it. Human research examining at least three times the amount of HCA than what's contained in the recommended dose of Javafit showed no effect on bodyfat. Citrus aurantium is the final compound on the list, and it too is scarcely supported in the scientific literature. It's typically administered as part of a mixture of compounds including caffeine, therefore it's difficult to determine its actual contribution to fat/weight loss.

A previous study showed Javafit's effectiveness at increasing endurance, as measured by time to exhaustion compared to a decaffeinated control. However, the present study did not see any enhancement of anaerobic power in Wingate sprints as a result of the supplement. Interestingly, the decaf control group had greater mean and maximal power than the Javafit group, but not to a degree of statistical significance. Excess post-exercise oxygen consumption (EPOC), an indicator of residual metabolic activity, was higher in the Javafit group. This is not surprising, since caffeine has elevated EPOC in previous research.

The superiority of Javafit over placebo is due primarily to its fortification with extra caffeine (150mg). Contributory effects of chromium, garcinia cambogia, and citrus aurantium are probably negligible, given their lack of effects when studied in isolation. Is this "functional" coffee's higher-than-Starbucks price justified? If one was inclined to buy caffeine pills, probably not. Chasing a No-Doz pill (200mg pure caffeine) with your favorite store-bought brew would be just as effective, and more economical – especially when you consider in shipping costs.

As much as the industry (and even secondary research) has downplayed caffeine's addictive potential, it indeed exists. In fact, caffeine withdrawal and caffeine dependence have been extensively investigated. Both are real phenomena. Whether or not caffeine's degree of addictiveness poses a problem is still under scientific debate. Certainly, this question must be assessed on an individual basis. To quote a recent paper by Roehrs and Roth, *"…the evidence indicates that caffeine, rather then enhancing performance, is merely restoring performance degraded by sleepiness."* Research varies in its severity of warning, but the risks shouldn't be sugar-coated. Man, writing this makes me crave a nice hot café mocha.

Tang JE, et al. Minimal whey protein with carbohydrate stimulates muscle protein synthesis following resistance exercise in trained young men. Appl Physiol Nutr Metab. 2007 Dec;32(6):1132-1138. [Medline]

PURPOSE: To determine the impact of consuming whey protein post-exercise on skeletal muscle protein turnover. **METHODS:** Eight healthy resistance-trained young men (mean age = 21 years) underwent a crossover trial in which they performed a unilateral leg resistance workout (EX: 4 sets of knee extensions and 4 sets of leg press; 8-10 repetitions/set; 80% of 1-rep max). One leg was not trained and acted as a rested (RE) control. After exercise, subjects consumed either an isoenergetic whey protein plus carbohydrate beverage (WHEY: 10 g protein + 21 g fructose) or a carbohydrate-only beverage (CHO: 21 g fructose + 10 g maltodextrin). Muscle protein synthesis (MPS) was measured via pulse-tracer injections of [ring-2H5]phenylalanine and [15N]phenylalanine. **RESULTS:** WHEY-EX stimulated a greater rise in MPS than CHO-EX. The latter treatments caused greater MPS than the unexercised controls, which did not show any significant differences in MPS regardless of the treatment used. **CONCLUSIONS:** A small dose of whey protein with carbohydrate can stimulate MPS after resistance exercise, potentially contributing to positive net protein balance, and potentially causing hypertrophy over time. **SPONSORSHIP:** A grant from the US National Dairy Council.

Study Strengths

It's always nice to use trained subjects in order to suppress the "newbie gains" possibility. This study required a minimum of 12 months of training, and the participants averaged 5 years. A rather extreme control measure – but a control measure nonetheless – was the requirement of an 8-month minimum absence of any dietary supplement intake (including protein supplements) prior to the trial. One-repetition maxes were tested on 2 separate occasions at least 2 weeks prior to the trial.

Study Limitations

The sample size was small (8 subjects), but this was partially alleviated by the use of a crossover treatment. Also, this was an acute study, not a chronic study carried over a period of weeks. Thus it's still stuck in the hypothesis-generating, rather than something more explicit and conclusive, such as if it measured body composition or strength change over time.

Eh, but those are common study flaws. The main shortcoming was the measurement of muscle protein synthesis while neglecting to measure muscle protein breakdown. Leaving out the latter doesn't give us any definitive measurement of what ultimately counts – net protein balance. The authors acknowledge the possibility of underestimating the impact of the treatments by not measuring muscle protein breakdown, but justify this by mentioning that muscle protein synthesis is the dominant determinant of net protein balance since it's typically 4-5 times greater than muscle protein breakdown in healthy young subjects. Nevertheless, it's ironic that they didn't take the extra step of measuring breakdown, given that two of the treatments were solely carbohydrate, whose primary effect (which they themselves mentioned) is an insulin-mediated suppression of muscle protein breakdown. Research by Rennie suggests that only a minor rise in insulin above basal levels is required to maximally suppress muscle protein breakdown as long as this occurs concurrently with elevated circulating amino acids. However, Rennie still maintains that the role of high elevations of insulin in net anabolism is only partially understood. In the final analysis, by not measuring muscle protein breakdown, concrete data was forgone in favor of mere speculation by the authors.

Comment & Application

What really didn't make a lot of sense was the justification for the small dose (21g) and choice carbohydrate (fructose). Quoting the authors, *"We chose, however, to not deliver a highly insulinogenic dose or source of carbohydrate since higher carbohydrate-induced hyperinsulinemia can suppress lipid oxidation (Labayen et al, 2004)."* In support of their strategy to avoid the suppression of lipid oxidation, the authors cite a single study with minimal relevance. Labayen et al compared the postprandial (post-ingestion) effects of two small meals (400 kcal) of equal caloric content, but differing in respective proportions of protein (15% versus 30%) and carbohydrate (55% versus 40%). Indeed, the lower-carbohydrate treatment caused a higher fat oxidation than the higher-carbohydrate meal. However, these meals were not ingested post-exercise. Let's take a look at the more relevant research, which the authors of the present study apparently didn't take into consideration when justifying their dosing scheme.

Back in 2000, a study led by Demling compared a casein hydrolysate-based protein-carb meal replacement powder (MRP) with a whey hydrolysate-based protein-only supplement on subjects undergoing a supervised resistance training program. Although total dietary carbohydrate was matched between the groups, the two daily doses of MRP yielded 38g of maltodextrin, a highly glycemic/insulinemic carbohydrate. Despite this, the MRP group lost almost twice as much fat, and gained twice as much lean mass as the protein-only group.

In more recent research on resistance trained subjects by Cribb et al, a carbohydrate-protein-creatine supplement was taken before and after training, totaling 64g whey protein plus 68g glucose. Despite the highly glycemic/insulinemic nature of both the protein and carbohydrate source, a small decrease in fat mass along with a significant increase in lean mass was observed. It's notable that these subjects were not in a hypocaloric balance, and still didn't gain fat as a result of the insulinogenic supplemental treatment.

In one of my favorite examples of the nearly bullet-proof post-exercise state, a study by Folch et al found that a post-exercise intake of nearly a pound of pasta (400g, yielding 297g carbs) resulted in zero de novo lipogenesis (fat synthesis) after 90 minutes of moderate-intensity cycling. In a similar acute trial by the same investigators done two years later, no de novo lipogenesis was seen in either the resting or post-trained state despite ingesting a 5g/kg dose of pasta in a single sitting – about double most people's intake of carbohydrate for an entire day.

LESS RECENT GEMS

Kreider RB, et al. Effects of ingesting protein with various forms of carbohydrate following resistance-exercise on substrate availability and markers of anabolism, catabolism, and immunity. J Int Soc Sports Nutr. 2007 Nov 12;4(1):18 [Medline]

PURPOSE: To investigate the effects of different carbohydrate (CHO) types on anabolic/anticatabolic and immune response after resistance training. **METHODS:** 40 subjects performed a standardized resistance workout and then ingested 40g whey + 120g of either sucrose (S), honey powder (H), maltodextrin (M). A non-supplemented control was observed as well. **RESULTS:** Glucose concentration 30 min after ingestion was highest in H**.** Although not to a statistically significant degree, H had a more sustained effect on glucose elevation. No significant differences were seen in levels of testosterone, cortisol, ratio of testosterone to cortisol, muscle & liver enzymes, or general markers of immunity. **CONCLUSION:** CHO and protein ingestion post-exercise significantly raises glucose and insulin. All of these forms of CHO are effective sources to ingest with protein for promoting post-exercise anabolic responses. **SPONSORSHIP:** National Honey Board (Longmont, CO) under the auspices of the United States Department of Agriculture (USDA).

Study Strengths

Randomized controlled trials in the sports nutrition vein are notorious for having dinky sample sizes. Although 40 subjects isn't a staggering amount by general standards, it certainly is a larger sample than many studies I've seen. Newbie effects or heterogeneity confounders were eliminated by using resistance-trained individuals. Time of day was standardized (within 2 hours) to eliminate diurnal variation. A broad range of relevant endpoints were assessed (immune factors, insulin, glucose, cortisol, testosterone, muscle & liver enzymes, perceived hypoglycaemia, dizziness, headache, fatigue), giving this study a decent bang-for-the-buck.

Study Limitations

As with all acute-effect studies, this one begs to be followed up by a chronic-effect study. The results hinted at the potential for a mixed carb source post-workout to yield the best results, and it would be interesting to see if any strength or body composition differences could be detected over a period of months. The amount of carbs (120g) was unusually large for a single dose; it resembled more of what would be consumed after glycogen-depleting endurance exercise than what would be consumed after the resistance protocol used (9 exercises covering the full body, 3 sets per exercise, 10 reps per set). Although it's remote, we shouldn't dismiss the possibility that such a high dose may have masked any differences between carbohydrate types. That would be unfortunate for those on a low-carb regime trying to get the nth-degree of effectiveness from a restricted intake. Nevertheless, my hunch is carbohydrate subtype wouldn't make a difference, regardless of dose.

Referring back to the opening article on nutrient timing, the pre-exercise meal can have a lingering hormonal effect on the post-workout period, especially when ingested immediately before a weight training bout of typical volume. Optimally, a pre-training protein/carb meal should be consumed to maximize substrate use by the working muscles. It's understandable to omit the pre-exercise meal for the study's purpose of isolating the effect of the post-workout meal, but it still leaves unanswered questions about the effect of a more complete protocol. For athletes with multiple exhaustive events in a single day, it would have been interesting to measure the rate of glycogen resynthesis. However, given the insignificant differences in insulin and glucose concentrations between treatments, a lack of difference in rate of glycogen resynthesis would be probable.

Comment & Application

After decades of investigation on protein and/or amino acids plus carbs (typically as either glucose polymers or sucrose), it's refreshing to see the effect of different carb types in combination with protein. Perhaps the most important finding here was the different carb types' lack of difference on insulin levels. This was especially striking considering the honey powder's composition was 31.5% fructose, 26% glucose, 25.3% wheat starch, 12.5% soluble fiber, and 4.7% maltose. The fructose and fiber content would lead one to presume a lesser effect on insulinemia and glycemia, but that wasn't the case.

Despite the honey powder's lower glycemic index (GI) than maltodextrin (sucrose has the lowest GI of the sources used), it still caused substantial glucose elevations. To quote the authors' conclusion which directly challenges the long-standing conventional wisdom, *"Consequently, one can not assume that adding a high GI CHO to a PRO supplement will yield the most advantageous glucose and insulin response."* Those obsessed with high-GI carbs post-workout might want to re-read that.

In future research, I would like to see whole food-based carbohydrate (oats, potato, rice, etc) pitted against refined carbohydrate (dextrose, sucrose, etc) or naturally derived simple carbohydrate such as honey. It would be helpful to compare the effects of various carbohydrates taken both pre- and post-exercise on body composition and strength, over a period of several weeks. In the latter scenario, I'd hypothesize that no significant differences would be seen among carbohydrate types, so choose according to your personal preference and tolerance.

Timing of post-workout carbohydrate is secondary to amount ingested. Bear in mind, the amount of post-workout carbohydrate is secondary to total amount for the day. With those foundational premises in place, nit-picking towards the optimal can begin. For some time now, I've recommended 0.5g carbs per lb of target bodyweight (1.1g/kg) in the immediate post-workout meal for most types of training. Coincidentally, Jentjens and Jeukendrup recommend an almost identical amount (1.2g/kg) in the immediate post-workout meal. Since their research is on endurance athletes, they recommend that this amount be ingested every hour for the 4-6 hours following competition.

Koopman, et al. Coingestion of carbohydrate with protein does not further augment post-exercise muscle protein synthesis. Am J Physiol Endocrinol Metab. 2007 Sep;293(3):E833-42. [Medline]

PURPOSE: To assess the effect of various amounts of carbohydrate combined with an ample amount of protein (Peptopro®, a casein hydrolysate) on post-exercise muscle protein synthesis. **METHODS:** 10 healthy, fit men (mean age = 20 yrs) were assigned to 3 crossover treatments. After 60 minutes of resistance exercise, 0.3g/kg/hr protein hydrolysate with 0, 0.15, or 0.6g/kg/hr carbohydrate was consumed during a 6-hr recovery period (PRO, PRO+LCHO, and PRO+HCHO, respectively). Blood and muscle samples were collected to assess whole body protein turnover and glucose kinetics as well as protein fractional synthesis rate (FSR). **RESULTS:** Plasma insulin responses were significantly greater in PRO+HCHO compared with PRO + LCHO and PRO. Plasma glucose rate of appearance (R(a)) and disappearance (R(d)) increased over time in PRO+HCHO and PRO+LCHO, but not in PRO. Plasma glucose R(a) and R(d) were substantially greater in PRO+HCHO vs. both PRO and PRO + LCHO. Whole body protein breakdown, synthesis, and oxidation rates, whole body protein balance, and FSR did not differ between treatments. **CONCLUSION:** Additional post-exercise carbohydrate does not further muscle protein synthesis when ample protein is ingested. **SPONSORSHIP:** DSM Food Specialties (Delft, The Netherlands).

Study Strengths

Dosage was proportional to body weight, instead of a flat amount ingested by all subjects. Dosage proportional to lean body mass would be ideal, but for some reason, that's rarely done in research. Assessment of plasma glucose kinetics (rates of appearance and disappearance) was a prudent step to ensure that ingested glucose was indeed absorbed by the gut when coingested with the protein treatments. All subjects were verbally encouraged during the exercise sessions, which lasted approximately an hour. Specific measures were taken to familiarize the subjects with the resistance training protocol, and a familiarization test was performed. Proper lifting technique was demonstrated and practiced.

Study Limitations

Perhaps the biggest flaw in this study is the excessive protein dose. At 0.3g/kg/hr, this comes to 1.8g/kg by the end of the assessment period, which is equal to what many trainees would ingest in an entire day – let alone within 6 hours post-workout. Although this dose accomplishes the goal of exceeding the amount of protein needed to provide maximal protein synthesis, it also erased much of the protocol's applicability to real life. Financially speaking, I suppose this study's sponsor (DSM Food Specialties), wouldn't mind if athletes consumed Peptopro® to the excess it was ingested in this protocol.

12 boluses, 30 minutes apart, were given for each treatment in the 6-hour recovery period. Although this high-frequency dosing was necessary to prevent large disturbances in the metabolic tracers, it isn't a realistic post-exercise meal schedule, which could have markedly different effects due to larger, less frequent amino acid and glucose influx. Having the same small set of subjects undergo the 3 different experiments potentiates a 'carry-over' effect, despite the 7-day washout periods.

Comment & Application

An abundance of studies have shown that post-exercise protein and/or amino acid intake stimulates protein synthesis. Post-exercise carbohydrate alone doesn't stimulate protein synthesis, but it inhibits protein breakdown. It's been suggested that carbs should be coingested with protein in order to maximize the insulin response. This traditionally has been presumed a major factor in achieving maximal net protein balance (protein synthesis minus breakdown). In contrast to previous studies using small amounts of amino acids (~6g total), this study demonstrated that ample protein (0.3g/kg/hr for 6 hrs) over-rides additional carbohydrate's ability to aid protein synthesis.

The authors observed that even in the absence of carbohydrate, insulin was sustained at levels where maximal protein synthesis (and inhibition of protein breakdown) occurs. However it's notable that lower plasma and muscle BCAA levels were seen when carbohydrate was coingested with the protein. This could have been due to an increase in amino acid oxidation, but the more plausible explanation is that the additional carbohydrate reduced muscle protein breakdown (hence less amino acid release into the blood). Thus, net protein balance may still be enhanced by carbohydrate in the presence of very high protein. Unfortunately, protein breakdown wasn't directly measured.

An additional treatment using a lesser amount of protein (say, 0.15-2.0g/kg/hr) would have provided some valuable information to compare with the existing treatment of 0.3g/kg/hr. A gradation of not just carbohydrate, but protein dosage as well, would come closer to providing a threshold of effectiveness for allowing carbohydrate to maximally contribute to protein synthesis – not just inhibition of protein breakdown.

However, while some might hastily interpret the results of this study as an ode to the uselessness of carbohydrate, the authors state specifically, *"However, as muscle glycogen content can be reduced by 30-40% following a single session of resistance type exercise, carbohydrate co-ingestion would be preferred when trying to accelerate muscle glycogen repletion."*

Since speed of glycogen resynthesis isn't critical for all sports, perhaps the more important consideration here is that carbohydrates are maximally partitioned into muscle tissue in the immediate post-workout period. To illustrate this, research by Folch's team showed a huge amount of carbohydrate (400g pasta containing 297g carbohydrate – a hell of a lot in a single sitting) consumed right after 90 minutes of moderate-intensity cycling (57% VO_2max) did not result in any lipogenesis. Basically, the body's fat-synthesizing machinery is shut off in the post-trained state, so carbohydrate at this time is used exclusively to meet the recovery demands of lean tissue.

LaCroix M, et al. Compared with casein or total milk protein, digestion of milk soluble proteins is too rapid to sustain the anabolic postprandial amino acid requirement. Am J Clin Nutr. 2006 Nov;84(5):1070-9. [Medline]

PURPOSE: To compare the postprandial utilization of dietary nitrogen from [^{15}N]-labeled micellar caseins (MC), milk soluble protein isolate (MSPI – which is synonymous with whey), and total milk protein (TMP). **METHODS:** 23 healthy subjects, 24-31 years old, ingested a meal containing MC, MSPI, or TMP. [^{15}N], a stable isotope of nitrogen, was measured for an 8-hr period in plasma amino acids, proteins, and urea and in urinary urea. **RESULTS:** The transfer of dietary nitrogen to urea occurred earlier after MSPI ingestion than after MC and TMP ingestion, and concentrations remained high for 8 h, concomitantly with higher but transient hyperaminoacidemia and a higher incorporation of dietary nitrogen into plasma amino acids. In contrast, deamination, postprandial hyperaminoacidemia, and the incorporation of dietary nitrogen into plasma amino acids were lower in the MC and TMP groups. Total postprandial deamination values were highest in the MSPI group. **CONCLUSIONS:** Despite its high Protein Digestibility Corrected Amino Acid Score, MSPI causes a rate of amino acid delivery that is too rapid to sustain an anabolism during the postprandial period. TMP topped the field in all of the tests. **SPONSORSHIP:** Arilait Research and the French Office of Research and Technology.

Study Strengths

Since habitual protein intake is known to influence the metabolic fate of protein, subjects underwent a week-long relatively well-controlled dietary adaptation/standardization period prior to testing. Although this period was home-based, they used lab-provided dietary notebooks containing daily menus and the specific quantities of food per meal. In addition, they were given food scales (accurate to the nearest 2 g) and daily record sheets. Subjects were instructed to comply with the protocol as closely as possible, and the authors report that a high compliance level was achieved across the board. Another plus was that the treatments were matched for carbohydrate content

Study Limitations

Sort of reaching here, but this trial was to compare the metabolic fate of dietary nitrogen from three different types of protein, and that's exactly what the investigators did. That said, it was an acute-effect study, and questions are left open about which protein would be superior for improvements in either lean mass gain, fat loss, or both – under exercising conditions, over an extended period of time.

Comment & Application

[Note: I confirmed with the authors that MSPI and whey are synonymous. Although technically, MSPI refers to whey purified by ultrafiltration. It can also be purified by acid precipitation, a less sensitive method.]

As expected, whey caused an immediate spike in post-meal hyperaminoacidemia. However, this was followed by marked *hypo*aminoacidemia by the sixth hour after the meal, which was not seen in the other groups. Also, the transfer of dietary nitrogen to urea was significantly higher in the whey group than in the other groups, especially during the first 2 hours. This means that the rapid and substantial rise in blood amino acids caused by whey was accompanied by a high rate of excretion of its nitrogen component. This led the authors to conclude that whey's higher content of indispensable amino acids (including leucine) was counterbalanced by high rates of amino acid deamination, reducing its potential net anabolic effect compared to the other treatments.

Interestingly (but perhaps not too surprisingly), total milk protein was the superior performer in all parameters, with casein in the middle, and whey in last place. To quote the conclusion, *"This result, together with the hypoaminoacidemia observed 4 h after the ingestion of MSPI, strongly suggests that a too-rapid dietary AA delivery cannot support the anabolic requirement throughout the postprandial period."* This is yet another indication that low-tech, inexpensive cow milk may be an ideal food for supporting muscle tissue, especially for those who don't have (or won't bother with) a high meal frequency.

Spirited debate is a fun thing to watch (and participate in). Anssi Manninen, a science journalist and owner of a line of products including whey hydrolysate, wrote a letter in disagreement with the conclusion and entitled his letter, "Postprandial nitrogen utilization and misinterpretation of data". The authors felt this accusatory title was false because as stated in their reply, *"...our conclusion was not a suggestion but a direct demonstration based on tracer kinetic data, and Manninen did not provide any data to suggest any misinterpretation of our data."*

Manninen contends that the authors' conclusion is misleading. He attempts to support his stance by citing one study showing whey hydrolysate beating casein for fat loss and lean mass gain over a period of 10 weeks. This would be a stronger argument if there weren't at least two other published trials suggesting that a whey/casein blend is superior for lean mass and strength gains. Manninen fails to mention these trials.

Finally, Manninen states that slow proteins are best suited for prolonged periods between eating, and fast proteins are best used post-workout. Instead of supporting this claim by directly referencing primary research, he references his own secondary research review article on post-exercise recovery. Incidentally, his article makes no mention of how substrates ingested pre-exercise influence post-exercise physiological demands. Nor does he mention the limitations of the current majority of post-exercise research on overnight-fasted subjects.

The bottom line is that the whey vs. casein post-workout "battle" is not a closed case. There is support on both sides, and currently there's more support for a blend of the two proteins than either in isolation. Wait a minute, that's how they occur in nature – as a blend... And it might be optimal that way, what a concept.

Paddon-Jones D, et al. Exogenous amino acids stimulate human muscle anabolism without interfering with the response to mixed meal ingestion. Am J Physiol Endocrinol Metab. 2005 Apr;288(4):E761-7 [Medline]

PURPOSE: To determine whether ingestion of a between-meal supplement containing 30g of carbohydrate (CHO) and 15g of essential amino acids (CAA) altered the metabolic response to a nutritionally mixed meal in healthy male volunteers, 28-48 yrs old. **METHODS:** 13 healthy active males underwent a parallel comparison. A control group (CON) received a liquid mixed meal every 5 hrs. The experimental group (SUP) consumed the same meals but, in addition, was given the CAA supplement between the meals. Net phenylalanine balance (NB) and fractional synthetic rate (FSR) were calculated during a 16-h primed constant infusion of L-[ring-2H5]phenylalanine. **RESULTS:** Ingestion of a combination of CAA supplements and meals resulted in a greater mixed muscle FSR than ingestion of the meals alone. Both groups experienced an improvement in NB after the morning. NB after CAA ingestion was significantly greater than after the meals. **CONCLUSION:** CAA supplementation produces a greater anabolic effect than ingestion of intact protein but does not interfere with the normal metabolic response to a meal. **SPONSORSHIP:** National Space Biomedical Research Institute Grant NPFR00205, and National Aeronautics & Space Administration Grant NAG9-1155, and Shriners Hospital Grant 8490.

Study Strengths

Healthy, young recreationally active males were used. Although this isn't necessarily a universal design strength, in my experience, that's the population most likely to use essential amino acid (EAA)-containing supplements. This study review thus will be of special interest to the bodybuilding message board crowd, known colloquially as the *"bros"* or *"brotelligencia"*. Ironically, in the paper's introduction and discussion sections, the authors repeatedly reference previous work showing EAA supplementation benefitting elderly subjects or those on prolonged bed rest.

Another study strength was the measurement of arterioveinous phenylalanine balance in addition to fractional synthetic rate (FSR) in mixed muscle protein. Phenylalanine was used with both methods because it's an essential amino acid that is not oxidized nor produced in muscle tissue. Therefore, its utilization in muscle can only be a result of muscle protein synthesis, and its release from the muscle is an index of protein breakdown.

Study Limitations

Small sample size and no structured exercise program are the more obvious design limits. However, the most profound limitation is in the trial's external validity. I found it rather far-fetched for the authors to speculate that additional CHO+EAA could possibly diminish rather than enhance the effect of the mixed meals on protein metabolism. The experimental and control treatments should have been isoenergetic and isonitrogenous (containing the same calories and protein). However, by the end of the 16-hr test period, the experimental group consumed a total of 45g EAA and 90g CHO above and beyond the control group. This is 540 kcal -- the equivalent of an extra full-sized meal with a substantial protein dose.

The mixed 'meals' consisted of a combination of Boost Plus (corn syrup & milk protein-based meal replacer), Polycose (glucose polymer solution), and Microlipid (safflower oil-based emulsion). Within the context of this study, the use of liquid meals has its pros and cons. It makes macronutrient control very precise. However, if application to a non-clinical population was weighed more heavily, solid food or at least food with a remote semblance of its natural state would be better suited To justify the use of liquid meals, the authors mentioned that they reduced the variability associated with digestion and gastric emptying of whole foods.

Aside from the treatment imbalance between groups, a crucial design flaw was a curiously low protein allotment in the control group, averaging 23g per meal, totalling 64g for the day, while the experimental group averaged 109g. It not only was a matter of treatment imbalance, but it essentially became a comparison of insufficient protein intake versus barely adequate intake, even by sedentary standards. Keep in mind that the "healthy, recreationally active" subjects averaged 87 kg (191.4 lbs), so the control group's protein intake at 0.73g/kg even fell short of the ultraconservative RDA of 0.8g/kg.

Comment & Application

In partial justification of this concern that the supplement might not enhance the overall effect, they cited past research by Fiatarone, where a mixed nutritional supplement added to the meal schedule of frail institutionalized elders had an appetite-suppressive effect. Thus, it failed to increase net caloric and nutritive consumption. Thus, the authors of the present study concluded that the additional protein-synthetic effect of the EAA+CHO supplement was a notable phenomenon. I personally saw nothing surprising – again, insufficient protein and calories were compared with barely adequate amounts. A longer-term trial with the same treatments used in this acute-effect trial would merely reiterate the obvious advantage of ingesting sufficient substrate amounts for building lean tissue.

Critical design flaws aside, an intriguing find of this study was the supplement's ability to increase net phenylalanine balance more than the meals, despite having similar EAA content. Even more perplexing, this effect was seen despite the supplement having a lower amount of leucine than the meal. These incongruous findings beg for a follow-up study with properly matched groups. The authors point to the possibility of a more rapid clearing of free-form amino acids from the gut causing a greater increase in extracellular amino acid availability acting as a signal for the stimulation of muscle protein synthesis. So, does this mean it's time to replace your steak and potatoes with sugar-spiked bottles of EAA's? I'd personally hold off – at least until more applicable data surfaces.

Van der Ploag, et al. Body composition changes in female bodybuilders during preparation for competition. Eur J Clin Nutr. 2001 Apr;55(4):268-77. [Medline]

PURPOSE: To determine body composition changes in female bodybuilders during contest preparation. **METHODS:** 5 competitive bodybuilders (averaging 35 years old, 66.38 kg, 18.3 %BF) were compared with 5 athletic controls in terms of height and percentage body fat (%BF) in the initial test of this longitudinal study. 8-site skinfolds, hydrodensitometry, total body water via deuterium dilution, and bone mineral mass via dual-energy X-ray absorptiometry (DEXA) was recorded at the start, finish, and end of 12-weeks. **RESULTS:** The bodybuilders lost a significant amount of total mass (5.8 kg), primarily due to a reduction in fat mass (FM; -4.42 kg; 76.2%) as opposed to fat-free mass (FFM; -1.38 kg; 23.8%). The decreases in body mass and FM over the final 6 weeks were greater than those over the first 6 weeks. Their %BF decreased from 18.3 to 12.7, and skinfold thickness decreased 25.5 mm collectively. **CONCLUSIONS:** Although bodybuilders had low %BF at the start, they still significantly decreased their body mass during the 12 weeks, and most of this loss was FM. **SPONSORSHIP:** Australian Research Council.

Study Strengths

Despite the inherent difficulty of the task, the control and experimental groups were closely matched in terms of starting stats. All subjects underwent testing at the same times to control same-subject biological variability. Perhaps the strongest aspect of this study was a thorough 4-compartment method of body composition (hydrodensitometry, skinfolds, DEXA, and total body water. Notably, skinfold measurements were done by an ISAK Level-3 anthropometrist, as opposed to someone with questionable experience or skill in that department.

Study Limitations

It would have been useful to see the exact exercise routines (i.e., bodypart training split, intensity scheme of the cardio-respiratory training, placement of training relative to food intake). Certain details of the exercise program were discussed, but other important details were not. Per body part, subjects reportedly did 2-3 sets of 10-12 repetition maximums (RM), finalized by a set of 6RM. This sounds like what may have been done *per exercise*, rather than *per body part*. In order for weight training bouts to last over an hour and only contain 3-4 work sets per body part, it's implicit that the full body was trained per workout. This is a highly unlikely scenario, given that they weight-trained 5 days per week. Unfortunately, subjects were not required to take diet records. Macronutrition and supplementation would have been valuable factors to assess.

Comment & Application

In natural (drug-free) competitions, leanness is the trump card of the top placers, especially since extreme muscular size isn't a commonality among the competitors in contest shape. Many competitors view contest prep muscle loss as a necessary sacrifice in order to achieve the extreme leanness required to get noticed by the judges. So, it made me smile to see the competitors only lose an insignificant amount of lean mass with the vast majority of their total weight loss (5.8 kg; 12.8 lb) coming from body fat. Novices commonly make the mistake of dieting too hard, over-training, or both. This results in an excessive drop in lean mass. In contrast, the competitors in this study were highly experienced (4-10 years of training). As such, it wasn't surprising that they were well-attuned to how their bodies respond to diet and exercise for the goal of muscle retention while dieting.

Except for one competitor who started the contest prep consuming approximately 2500 kcal and ended off consuming 1250 kcal, the rest reported a consistent intake of approximately 1530 kcal. It's safe to assume that this is a significant underestimation of intake, given the lack of muscle loss. Unintentional severe underreporting of caloric intake (at or greater than a 20% discrepancy) is a common occurrence in both normal-weight and obese individuals, and it's more prevalent with women than men.

One of the most notable results of this study was the retention of lean mass during a calorie deficit coupled with a high volume of training. Except for one subject who did 8.16 hours of aerobic training per week for the entire 12-week period, the competitors did 5.7 hours of aerobic training per week, which at 4 weeks prior to the competition was increased to 9.8 hours per week by adding an extra session per day. 5 days per week of weight training totalled 5.7 hours. This adds up to a combined weekly total of 11.4-15.5 hours of training. It's typical for fat loss to slow down as a contest approaches and competitors reach their lower limits of leanness. However, as a result of the increase in exercise volume, the competitors' fat mass decreases in the final 6 weeks were actually greater than those in the first 6 weeks.

As a matter of coincidence, I recently prepared a client for a late-notice photo shoot where he had to lose 6-7% of his starting bodyfat in a little over 2 months. The consequences could have been severe (a couple of models were actually rejected from the shoot after showing up in sup-par shape), but we achieved the goal. His starting training volume was 12 hours per week, which we kicked up to 15 hours per week during the final month.

I recently had a discussion with an online forum member who asked whether it was possible to get in great shape doing a total of 3 hours per week of training. My response was: decent shape? Yes. Contest shape (sharply visible abs and the whole shebang)? Not unless you're genetically gifted. This didn't sit too well with him, but hey it's reality. In my experience, people can achieve a fair degree of leanness on anywhere from zero exercise hours a week on upward. However, those who consistently stay in magazine cover shape maintain a ballpark range of 8-13 hours of total training per week. Those who have less extreme goals can maintain an athletic physique on roughly 4-7 hours per week. Of course there are always exceptions, and remember that these numbers are based on my personal observations with clientele, not universal absolutes.

IN THE LAY PRESS

Rousell M. Build and burn: muscle building for the 21st century. Dec 5, 2007. [Testosterone Nation]

For those of you who just clicked the link to this article and had a mild coronary event because of the pictures of women in thong bikinis, please accept my apologies.

Background & Context

The title of "Build and Burn" implies the attainment of the Holy Grail of more muscle and less fat. This is an appropriate topic for the targeted audience of T-nation.com, which consists of young bodybuilding and fitness enthusiasts. The site is known for juxtaposing a "hardcore" vibe with an attempt to remain scientific – and from the little I've seen, these two objectives mix as well as North and South Korea. However, I have indeed read an article there that I for the most part agreed with, entitled "The Hierarchy of Fat loss" by Alwyn Cosgrove.

Key Premises

Back to Rousell's article. The underlying premise is that it's not a good idea to gain a lot of fat in the process of gaining muscle. I agree with this. I personally am not aware of any objective data indicating that gains in muscular size and strength can occur faster alongside proportional gains in bodyfat, as opposed to without fat gain, or minimal fat gain. Rousell asserts that the old-school practice of drastic "cutting" and "bulking" cycles is less than optimal, since each phase takes its objective to an extreme with little regard for the type of tissue being lost or gained.

As an alternative, he presents a model currently used by drug-free professional bodybuilder Layne Norton, involving 6-8 weeks of caloric surplus interspersed with 2-3 weeks of caloric restriction. Nothing too eyebrow-raising here – but that would really depend upon the magnitude of the surplus and deficit. Rousell proposes the acceptance of roughly a pound of fat gain for every 3 pounds of muscle gained. So the idea is to bulk for 1.5-2 months, then interject a couple of dieting weeks to burn off about 2 pounds of fat, and repeat the cycle. That sounds great on paper, and it might work well for those under Norton's personal supervision, but it's certainly not indisputably the best route.

"Thus, after an eight week muscle building cycle where five pounds is gained, they'd only need to take two weeks to burn off the less than two pounds of fat gained."

Alternating cutting and bulking cycles can serve as a boredom deterrent (as well as a means to fulfill the desire to pig out and repent afterward). However, I see no physiological advantage over a more linear progression of muscle gain while minimizing or even losing fat. To use Rousell's above example, gaining 5 lbs every 8 weeks – with less than 2 of the 5 lbs being fat – equates to roughly 1.5 lbs muscle gained per month, which ends up being 18 lbs of muscle gained in a year. Is this realistic? Yes, but this rate of gain is likely going to happen in beginners and intermediates, not advanced trainees. Getting specific about realistic rates of fat-free muscle gain, my field observations have lead me to ballpark the following guidelines: Complete novices can gain approximately 2% of their total bodyweight per month. Intermediates can gain 1-1.5% of their total bodyweight per month. Advanced trainees near their genetic potential are lucky to gain 0.5-1.0% of total bodyweight gain as fat-free muscle per month. This is why it's quite an accomplishment when bodybuilders who have been at it for years gain 7-10 lbs of fat-free muscle in a year. By contrast, it's not too uncommon to see a rank newbie gain double that amount in their first year of training.

But here's the point I want people to get a grip on: It's possible to achieve identical fat-free muscle gains by either a linear method or a cyclical method that involves more marked fluctuations in bodyfat. The problem I've observed is that alternating cutting and bulking cycles often keeps people on a perpetual yo-yo diet rollercoaster, where they look great half the time, and the other half of the time they look bloated and smooth. Or in Rousell's example, smooth (and potentially bloated) for 2/3 of the time, and lean & sharp the rest of the time. That scheme doesn't suit my personal preference nor does it click with the population I primarily work with, who want to look as good as possible 100% of the time. There are obvious exceptions where specific phases suit the sport (ie, precontest dieting for competitive bodybuilding), but here's my underlying premise: there's more than one way to skin a cat, each way has its pros and cons, and ultimately it boils down to individual preference and tolerance. My preference is for steady, unexciting, linear improvement. It seems slower, but it's actually not, and you look better doing it.

"The new mass building foods are 'clean' foods."

Ah, the lovely "clean foods" concept. Rousell provides a list of foods that for the most part are traditional good-for-you fare (whole foods across the range of food groups). It was a pleasant surprise to see him include white rice, since many bodybuilding and fitness buffs avoid anything white. This is perhaps because it's tough for many fitness zealots to see their world in anything but black and white terms. Ironically, he left out white pasta – bummer. As expected, the devil's poison (milk) was not on the list, but at least he gave a green light to the Puke of the Gods (cottage cheese).

With that said, there's no objective evidence indicating that the micro-management of specific food subtypes, rather than the manipulation calories and macronutrition, is superior for gaining muscle or losing fat. In the cases of certain "junk" foods, it simply boils back down to their tendency to be overconsumed in terms of calories. As long as people achieve their macronutrition targets with a predominance of whole foods, specific subtypes of food are best left to personal preference.

"...you may need to reduce your fruit and vegetable intake during your mass gaining phase in order to get in enough calories."

I see the point being made here, but again, given the cycle Rousell proposes, you'd be cutting back on fruits and vegetables for 2/3 of your waking hours as a humble mortal trying to build a super-hero physique. The implications of this from long-term health standpoint aren't too promising.

"During building phases, the focus has traditionally been on consuming higher glycemic/starchy carbohydrates. These foods provide more carbohydrates and calories than fruits and vegetables, but because of their ability to stimulate insulin they may add to your gut a little faster. The other option, one often over looked, is to increase your legume consumption."

Rousell seems to be contradicting his previous idea that foods high in water and fiber are not conducive to increased calorie consumption. But perhaps the bigger issue is the effect on the atmosphere if everyone simultaneously decided to bulk on beans. I say that in partial jest, because the technical aspects I want to address are centered on his discussion of insulin.

"Proper timing of insulin spikes during building phases will maximize muscle growth. While controlling insulin during fat loss phases will allow you to drop your recently gained blubber, so you can stay lean and get back to packing on muscle."

This is not dangerous advice, nor is it counterproductive advice. It's just at best oversimplified, and at worst, fraught with incorrect implications. First of all, there's no need to spike insulin unless you trained fasted and are in a dire hurry to replenish glycogen for your next glycogen-depleting endurance event occurring that same day. Otherwise, there's likely going to be some degree of previous-meal insulinogenic overlap. And technically, as long as amino acid levels are elevated, only a small rise in insulin is required to maximally stimulate muscle protein synthesis and inhibit protein breakdown. I go into the specifics of this in the opening article of this issue right here.

"Controlling insulin is extremely important."

This premise is emphasized repeatedly in the article, and I disagree with it, since the most potent culprit for fat gain is an unused surplus of calories. There are other agents of lipogenesis such as acylation stimulating protein (ASP), which can facilitate fat storage in the absence of insulin. For the readers out there, Jamie Hale provides a concise, research-based review of ASP in his book Knowledge and Nonsense, which happens to contain a ton of other good information as well.

In the same breath that Rousell urges you to control insulin, there's this specific recommendation:

"Note: Consume three to five Biotest BCAA tablets between meals."

Now, I've known for some time that BCAA (leucine in particular) has potent insulinogenic effects. Therefore, it always bewildered me when folks contradict themselves by saying you have to suppress insulin output as much as possible except post-workout and upon waking in the morning – yet at the same time, you're given the perfect tactic for hiking up insulin all day long. Illustrating my point, recent research by Nilsson and colleagues demonstrated that the addition of 4.4g BCAA raised the insulin output of a 25g glucose solution by 39.6 %. Flipping the concept around, does this mean that BCAA will automatically cause insulin-mediated fat gain as long as glucose is being absorbed into the blood during the time of supplementation? Of course not. Insulin's interactive role in the scheme of applied physiology is only minimally understood, so we shouldn't confuse the little we know. The take-home point is, controlling insulin pales in importance to controlling the degree of caloric deficit or surplus.

In summary, this article was not dominated by dangerous or patently asinine advice, it just had a high enough share of technical twist-ups and inconsistencies for me to address it. The net effect of the article is positive in that it encourages people to eat more whole foods and avoid excessive fat gain en route to getting hulkin' huge. Sure, there's a mind-numbing dose of product advertising throughout, but that's the nature of the beast at T-nation, and it was fairly easy to acclimate to. It's mainly the pictures of thong-clad women that might distract some readers. Ultimately, Rousell's article was interesting and provocative enough to make it into the inaugural issue of my research review.

NEXT MONTH

In addition to reviewing the current and past-yet-juicy studies, I'll look at the theory and practice of protein and carbohydrate timing. I'm open to suggestions, comments, questions, and civil debate (letters to the editor). Send your correspondence to aarrsupport@gmail.com. Until next month, enjoy the start of 2008.