



SPORTS SCIENCE EXCHANGE

NUTRITIONAL SUPPLEMENTS FOR WEIGHT GAIN

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KEY POINTS

1. Among the most popular nutritional supplements marketed to enhance muscle mass are chromium, creatine, vanadyl sulfate, boron, beta-hydroxy-beta-methyl butyrate (HMB), protein powders, and amino acids.
2. Chromium is a trace mineral that potentiates the effects of insulin. Well-controlled studies found that chromium supplements did not increase muscle mass.
3. Creatine, found in meat, has been shown to increase body weight in some individuals. The short-term increase in weight appears to be due to water retention, but researchers are currently investigating the possibility that longer-term weight gain might be due to greater accumulation of muscle protein.
4. Vanadium is a non-essential trace mineral that supposedly has insulin-like effects. It has not been found to increase muscle mass. Boron is a non-essential trace mineral whose function is not clear; it does not increase muscle mass.
5. HMB is a metabolite of the amino acid leucine. One study found that HMB increased muscle mass and strength and reduced muscle breakdown during resistance training. Additional research is needed to determine if these results can be duplicated and to address possible mechanisms and safety considerations.
6. Protein supplements are not needed to build muscle mass because sufficient protein (1.4 to 1.8 g of protein/kg/d) can be obtained through the diet. Although the "high tech" protein supplements include a variety of additives purported to boost weight gain, most have never been tested to evaluate their efficacy.
7. Research demonstrates that gains in muscle mass and strength occur when a well-nourished athlete (i.e., adequate energy and dietary protein) engages in a well-designed strength-training program.

INTRODUCTION

A muscular physique for men has long been the standard. Starting in the 1920s, advertisements for the Charles Atlas bodybuilding system portrayed a four-part comic strip of the 97-pound weakling at the beach getting sand kicked in his face by a muscular bully. The scrawny fellow then takes the Charles Atlas exercise course, returns and defeats the bully. Although the Charles Atlas exercise program is still offered today, the perfect body exemplified by Charles Atlas pales in comparison to the muscular physiques displayed in current bodybuilding or "muscle" magazines. Many bodybuilders doubt that weight training alone can achieve the very muscular standards of today's bodybuilder. Those who do not want to risk their health by using drugs to build large muscles, have instead turned to nutritional supplements.

Among the most popular nutritional supplements advertised to enhance muscle mass are chromium, creatine, vanadyl sulfate, boron, beta-hydroxy-beta-methyl butyrate (HMB), protein, and amino acids. These supplements are often promoted and available for purchase in weight training centers, by mail order, and by ordering over the Internet. The popularity of weight gain supplements has increased over the years in parallel with the cultural aesthetic for men to be more muscular. This paper will review the theory behind these popular supplements and present results of studies that have evaluated their efficacy.

CHROMIUM

Chromium is a trace mineral that is essential for life. Because of insufficient methods to assess chromium status, the U.S. Food and Nutrition Board could not establish a recommended dietary allowance (RDA) for chromium. Instead, a range of values (called the estimated safe and adequate daily dietary intake, ESADDI) of 50-200 μg is recommended (Food and Nutrition Board, 1989). Anderson & Kozlovsky (1985) suggested that many people in the United States are not ingesting even 50 μg of chromium per day. However, the ESADDI was established using less sophisticated equipment than is available today, so the recommended values may be high (Stoecker, 1996).

Chromium potentiates insulin action, and insulin stimulates glucose and amino acid uptake by cells (Lefavi et al., 1992; Mertz, 1992). It is thought that by stimulating amino acid uptake, there will be an increase in protein synthesis and muscle mass gain. In fact, chromium supplements do increase muscle mass and growth in animals (Stoecker, 1996). However, chromium's effect on muscle mass in humans is less clearcut. Chromium is marketed predominantly in the form of chromium picolinate, although chromium nicotinate and chromium chloride supplements also exist. Picolinic acid is an organic compound that serves to bind chromium and is thought to enhance the absorption and transport of chromium (Evans, 1989).

Evans (1989) was the first to report that ingesting chromium increased lean tissue in exercising humans. In the Evans' studies, untrained college students and trained football players were given 200 μg of chromium picolinate or a placebo each day for 40-42 d while they were on a resistance exercise program. The authors reported that those subjects who took chromium supplements gained significantly more lean body mass compared to the placebo group. However, lean body mass was only estimated from circumference measures, and the changes observed were small so that measurement error could have influenced the results.

Four subsequent studies were not able to confirm the results of the Evans' studies. Hasten and colleagues (1992) gave students participating in a strength-training program either 200 μg of chromium picolinate or a placebo for 12 wk. Only small increases in body weight were found for males either on the placebo or the chromium supplements or for females on the placebo. However, females who took the chromium supplements gained 2.5 kg of body weight (Figure 1). Lean body mass was not assessed. The authors offered several speculations for the increase in body weight for the females taking chromium: 1) females may have a chromium-deficient diet (diet was not assessed); 2) the dose per body weight was greater for females; 3) females may be less insulin resistant than males, and 4) the relatively large gain found for untrained subjects just beginning a strength-training program may mask any effect of the supplement for

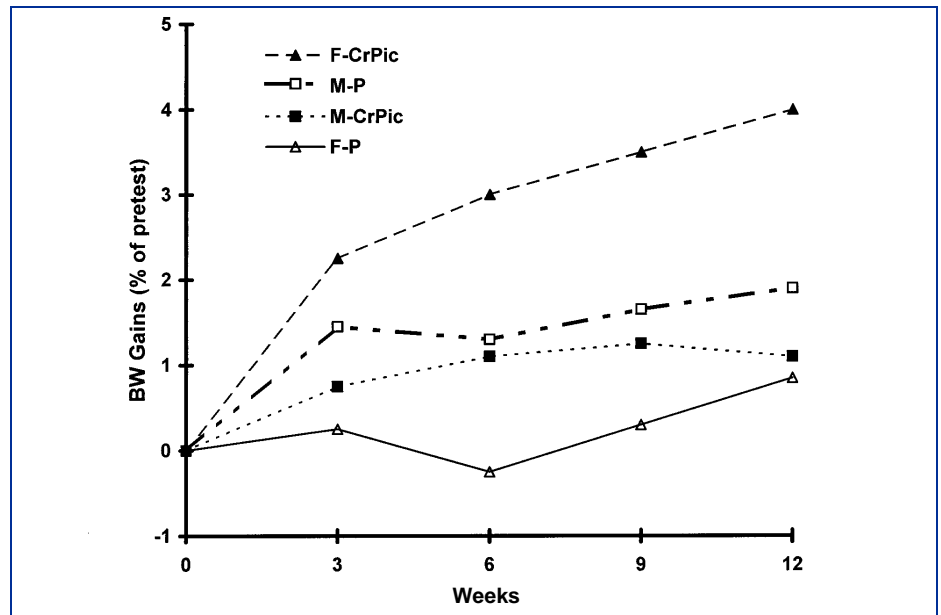


FIGURE 1. Body weight gains over 12 wk expressed as a percentage of initial weight. F-CrPic = females taking chromium picolinate supplements; M-P = male subjects taking the placebo; M-CrPic = male subjects taking chromium picolinate supplements; and F-P = female subjects taking the placebo. Modified from Hasten et al. (1992).

the males. Further studies are needed to confirm this effect for females and to determine the reason why females may benefit more than males from chromium supplements during strength training.

To further examine the effects of chromium on lean body weight in athletes, Clancy and colleagues (1994) gave chromium picolinate (200 $\mu\text{g}/\text{d}$) supplements or placebo for 9 wk to college football players participating in a strength-training program. Underwater weighing and anthropometric measurements were used to assess changes in body composition, food diaries were kept, and urinary chromium excretion was assessed. There was no difference between the chromium supplement and the placebo on changes in skinfold measures, percent body fat, lean body mass, and circumference measures. Urinary chromium excretion before supplementation was low and undetectable in many subjects, and this was also found for the subjects in the placebo group throughout the

study. However, for the chromium-supplemented group, urinary chromium excretion significantly increased at 4 wk and remained elevated through 9 wk. These data suggest that chromium stores were adequate and that extra ingested chromium was excreted into the urine. Another study (Hallmark et al., 1996) using virtually the same study design as Clancy et al. (1994), but with untrained males, also found no benefit of chromium supplements on lean body mass.

In a well-controlled study, Lukaski and colleagues (1996) examined the effect of 8 wk of chromium chloride, chromium picolinate, or a placebo in untrained men who started a resistance-training program. Body composition was carefully assessed by skinfolds, circumferences, and dual X-ray absorptiometry. Compliance and dietary intake were also assessed. The two types of chromium supplements similarly increased urinary chromium excretion and had no effect on body composition (Figure 2).

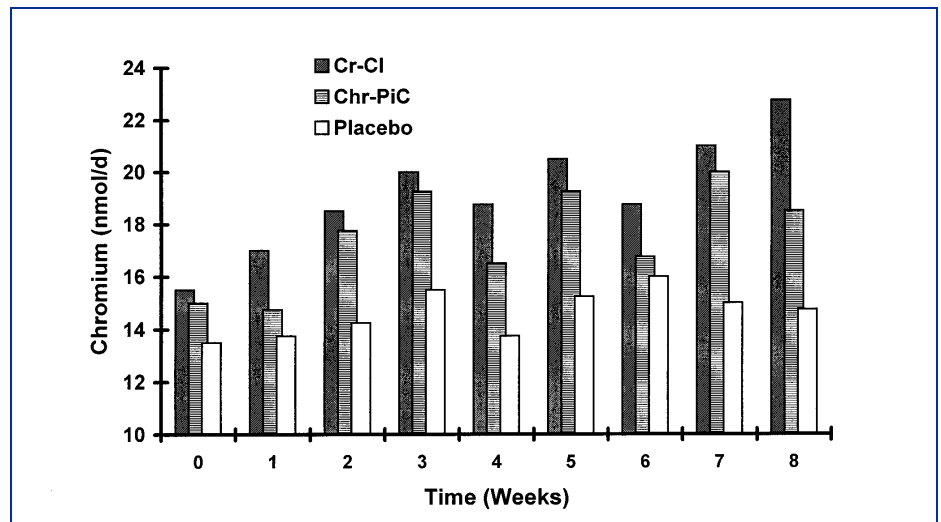


FIGURE 2. Urinary chromium excretion in 3-d pooled samples taken prior to (0) and during 8 wk of resistance training while taking either chromium chloride, chromium picolinate, or placebo. Modified from Lukaski et al. (1996).

The preponderance of the data show that chromium supplements are not effective in increasing lean body mass. Based upon laboratory studies of cultured cells, it was suggested that chromium picolinate could accumulate in cells and cause chromosome damage (Stearns et al., 1995a; Stearns et al., 1995b). While this has not been proven in human studies (McCarty, 1996), a prudent course of action would be to ingest foods rich in chromium. Some foods rich in chromium are brewers yeast, American cheese, mushrooms, and wheat germ.

CREATINE

Creatine is found in meat and fish. Once ingested it is absorbed unchanged from the intestinal lumen into the blood. It is carried to tissues such as skeletal muscle, where specific protein transporter molecules in the muscle cell carry creatine directly into the muscle. Creatine is also synthesized in the body from the amino acids glycine and arginine. In skeletal muscle, creatine combines with phosphate, forming creatine phosphate, an important source in providing a phosphate to adenosine diphosphate to regenerate adenosine triphosphate (ATP), the primary fuel for muscle.

Creatine has become one of the most popular nutritional supplements of the past decade (Balsom, 1994; Volek & Kraemer, 1996). Many, but not all, scientific research studies to evaluate creatine as an ergogenic aid have found that creatine ingestion improved repetitive, short-term, strenuous exercise performance, but its effectiveness is still debatable (Mujika and Padilla (1997).

A "side effect" of creatine supplements is an increase in muscle mass. Several studies have found that creatine supplements (20-30 g/d for about 5 ds) resulted in a significant increase in body weight of about 1 to 3 kg (Balsom et al., 1993a and b; Balsom et al., 1995; Earnest et al., 1995; Green et al., 1996; Greenhaff et al., 1994; Jacobs et al., 1997; Mujika et al., 1996; Söderlund et al., 1994; Stroud et al., 1994; Volek et al., 1997). However, a few studies have not found a significant increase in body weight (Earnest et al., 1997; Grindstaff et al., 1997; Prevost et al., 1997). It should be noted that 20 grams of creatine is about the amount contained in 5.5 kg of raw steak (Eichner, 1997).

In one study in which subjects ingested 30 g of creatine for 6 d, the subject who gained the most weight (2.5 kg) was a vegetarian (Balsom et al., 1993a). Creatine uptake by tissues appears to be greatest in vegetarians (Harris et al., 1992), which is probably due to the fact that vegetarians have lower muscle creatine stores (Delanghe et al., 1989). While some subjects show large increases in body weight, other subjects show little change. The variability in response to creatine may reflect an individual's initial creatine status.

The mechanism to explain the increase in body weight is not known. Ingestion of 20 g

of creatine resulted in marked increases of muscle creatine levels in 4-5 d (Harris et al., 1992). Creatine could act an osmotic agent in skeletal muscle and increase water retention in cells (Volek & Kraemer, 1996). Hultman et al. (1996) found that when subjects took creatine, there was a decrease in urine volume, indicating a retention of water. Preliminary studies suggest that there may be some increase in protein synthesis as well as a retention of fluid (Ziegenfuss et al., 1997; Flisinska-Bojanowska, 1996).

The safety of creatine supplements was called into question in December, 1997, after three collegiate wrestlers died, and it was speculated that creatine may have contributed to their deaths. However, these wrestlers were undergoing dangerous dehydration procedures that more than likely resulted in fatal thermal stress. Any contribution that creatine may have had has not been proven. Anecdotal information from athletic trainers suggested a relationship between creatine and muscle cramps, muscle spasms, and even pulled muscles. It was postulated that the increased water retention in muscle may have caused these problems, but this has never been examined or documented. Although laboratory studies have reported minimal or no side effects of creatine ingestion, these studies have used protocols of a relatively short duration (from 4 days to less than two months). The long-term use of high doses of creatine has not been examined. The manufacturer's recommended dose is usually 20 gram of creatine per day for 5 d and then continuing on a maintenance program of 2-5 g per d. Athletes could be taking higher doses for longer periods of time, thinking that if a little is good, more is better. Further research on the long-term effects of creatine supplements at various doses are needed to determine whether creatine ingestion is safe and under what circumstances one may need to exercise caution.

VANADIUM

Vanadium is a trace mineral that has not been deemed essential for human life. Although there is little information from which a requirement for humans can be based (Food and Nutrition Board, 1989), a daily dietary intake of about 10 µg of vanadium will probably meet any postulated vanadium requirement (Nielsen, 1996). Vanadium deficiencies in animals can produce deleterious effects and shorten life span, but no vanadium deficiencies in humans have been observed. Numerous functions for vanadium have been proposed, including an insulin-like role in promoting transport of amino acids into cells. Because enhanced amino acid uptake by muscle is thought to increase muscle mass, vanadium, in the form of vanadyl sulfate, is widely marketed as a muscle builder. Data suggesting that vanadium has anabolic effects are derived from laboratory studies of cells and laboratory animals (Nielsen, 1996).

Because there is not sufficient information that vanadium is an essential element for humans, there is no established RDA or ESADDI (Food and Nutrition Board, 1989). The Food and Nutrition board concluded that if nutritional requirements exist they are low and easily met by levels naturally occurring in foods (Food and Nutrition Board, 1989). Foods rich in vanadium include mushrooms, shellfish, and parsley. Fruits, vegetables, fats and oils contain the least amount of vanadium (Nielsen, 1996)

It was suggested that some athletes may be taking up to 60 mg/day for 2-3 mo to increase muscle mass (Fawcett et al., 1996). However, no studies have proven that vanadium supplements have an anabolic effect in humans. In the only study to evaluate vanadium supplements, subjects ingested 0.5 mg/kg/day of vanadyl sulfate or placebo for 12 wk during a strength-training program, and the results showed no beneficial effect on body composition as assessed by anthropometric measures or DEXA scans (Fawcett et al., 1996).

Vanadium supplements could have detrimental effects when taken for a long period of time. Supplements of up to 13.5 mg vanadium/ day for 6 wk or 9 mg for up to 16 mo were not toxic. However, larger doses produced diarrhea, green tongue, gastrointestinal disturbances, and cramps (Nielsen, 1996). There is no basis at this time to suggest that vanadyl sulfate is useful as an anabolic agent for athletes, and large doses over a period of time could prove harmful.

BORON

Boron is an essential element for plant growth, and it may be an essential nutrient for animals, but for humans there is not sufficient information to establish an RDA or ESADDI (Food and Nutrition Board, 1989; Nielsen, 1996). A national database on the boron content of foods does not yet exist, but boron intake is estimated to range between 0.5 and 3.1 mg (Nielsen, 1996). Based on animal studies, about 1 mg/d of boron may be needed. Boron is present in foods of plant origin, with noncitrus fruits, leafy vegetables, nuts, and legumes as rich sources (Nielsen, 1996). How ingested boron is transported through the body is not known. Boron is distributed throughout soft tissue of the body but has its greatest concentration in bones, fingernails, hair, and teeth (Nielsen, 1996).

The exact function of boron has not been identified, but it is thought that boron affects calcium and magnesium metabolism and membrane function (Chrisley, 1997). Boron was purported to increase muscle mass by increasing testosterone. One study found that 3 mg boron/d lowered urinary calcium loss in a low-magnesium diet and increased serum estrogen and testosterone in postmenopausal women (Nielsen et al., 1987). However, it was also found that 3 mg boron/d for 10 mo altered serum min-

eral levels but did not affect circulating hormones (Meacham et al., 1994; 1995; Volpe et al., 1993a; 1993b). In the only study of boron effects on muscle mass in males, Green and Ferrando (1994) examined the effect of daily supplements of 2.5 mg boron or placebo for 7 wk in male bodybuilders and found no difference between groups in lean body mass, total testosterone, and strength over the course of the 7 wk. At present there is insufficient information to conclude that boron supplements will increase muscle mass in athletes.

BETA-HYDROXY-BETA-METHYLBUTYRATE (HMB)

HMB is derived in a metabolic pathway in which the essential amino acid leucine is converted to HMB, hence HMB is called a metabolite of leucine. In addition to being made in the body, HMB is found in some foods such as citrus fruit and catfish. HMB is not an essential nutrient. The exact function of HMB in the body is not fully known but in humans, it is purported to increase muscle mass by preventing protein breakdown that occurs with intense resistive exercise and enhancing the repair process (Nissen et al., 1996).

Although some abstracts are available to support the contention that HMB has anabolic properties in humans, only one peer-reviewed publication exists (Nissen et al., 1996). In the first experiment in this study, the effects of ingesting 0, 1.5, and 3.0 g HMB/d for 3 weeks were examined in men who were undergoing standardized strength training 3 d/wk with the sessions monitored by trained supervisors. The supplemented groups gained more lean body mass than the placebo group and the higher dose resulted in the greatest gain (1.21 kg) over the 3 wk. Higher doses also caused the greatest gain in strength (total of upper and lower body exercises). In the supplemented groups, muscle protein breakdown decreased during the first 2 wk of training, and there was less evidence of muscle damage.

In the second experiment, subjects trained for 7 wk, and the intensity of the exercise was increased. This experiment also found that 3.0 g HMB/d for 7 wk significantly increased fat-free mass and bench press strength (but not the squat lift and the hang clean) compared to the placebo. These results are interesting and lend support to the contention that HMB can work as an anabolic supplement during strength training. However, the amount of weight gain is not dramatic. Diet was controlled in the first study where meals were supplied as frozen entrees and packed lunches, but was not controlled in the second study. Nevertheless, further studies are needed to replicate these results, determine a possible mechanism of action, and determine the safety of long-term use.

PROTEIN

Many supplements containing protein and various amino acid combinations are marketed to those desiring to increase muscle mass. The USRDA for protein intake is $0.8 \text{ g} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ (Food and Nutrition Board, 1989), but several studies have indicated that athletes require a greater amount. Other reviews are available for additional information concerning protein requirements in athletes (Lemon, 1991; 1992; 1994).

Resistance exercise increases protein synthesis and can cause a negative nitrogen balance (Chesley et al., 1992; Marable et al., 1979; Yarasheski et al., 1993), which suggests a need for increased protein in the diet. Studies reported that a protein intake of about 2.0 g of protein $\cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ was required to maintain a positive nitrogen balance in strength-training athletes (Celejowa et al., 1970; Laritcheva et al., 1978). When 2 g of protein $\cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ was consumed by strength athletes above their normal dietary intakes of 1.3 g of protein $\cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ for 4 wk (a total of $3.3 \text{ g} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$), whole body protein synthesis increased, and significantly more lean body mass was achieved (Fern et al., 1991) (Figure 3). This study also found an increase in amino-acid oxidation, which may suggest that protein intake exceeded what was needed for muscle growth (Lemon, 1994). Tarnopolsky et al. (1992) reported that increasing protein intake to 2.4 g of protein $\cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ did not increase protein synthesis more than intake of $1.4 \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$, but the larger intake of protein did increase amino-acid oxidation. Thus, the extra dietary protein was broken down for energy rather than being incorporated into more muscle protein.

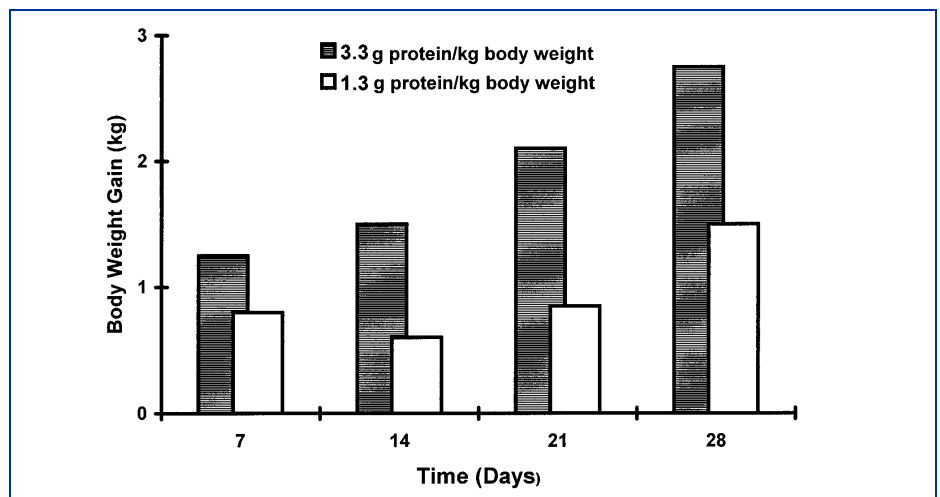


FIGURE 3. Changes in body weight over 28 d while subjects ingested daily a diet of either 1.3 g of protein/kg of body weight or 3.3 g of protein/kg body weight. All subjects participated in a heavy-resistance training program during the 28 d. Modified from Fern et al. (1991).

Lemon (1995) recommended that athletes ingest 1.4 to 1.8 g of protein $\cdot \text{kg}^{-1} \cdot \text{d}^{-1}$. A beginning athlete in the first 2-3 wk of training may need more protein than an experienced athlete (Lemon, 1992). However, once adapted to the training, a positive nitrogen balance returns, so ingestion of protein at the low end of the range is suggested for experienced athletes, and at the high end for beginners. At this point there is not sufficient information to defini-

tively state that protein intake above 2.0 g of protein $\cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ will enhance muscle mass relative to more moderate intakes.

Most athletes ingest a large amount of energy, and their protein intake generally meets or exceeds the recommended range for strength-trained athletes. Athletes ingesting energy-restricted diets, athletes who make poor food choices, and vegetarian athletes may not meet their protein needs. Both adequate energy and adequate protein intakes are needed to promote gains in muscle mass. In fact, protein needs can be greater when energy intake is low (Butterfield et al., 1992). Also, inadequate ingestion of carbohydrate results in more rapid depletion of glycogen during exercise and could contribute to increased use of protein for energy (Lemon, 1992).

Strength-trained athletes who are determined to increase their protein intake must be careful not to ingest additional red meat or whole eggs, which are high in fat. If athletes are concerned that they are not ingesting the recommended amount of protein in the diet, an inexpensive and good source of protein is dry milk powder (casein) which will provide all the necessary amino acids at less than half the cost of the "high tech" protein supplements marketed to athletes. However, the majority of such supplements do provide additional energy and protein. The efficacy of other protein formulations for weight gain, which include such ingredients as whey protein or "special" enzymes, have not been scientifically tested, so there are no data to support the contention that they will promote muscle gain.

AMINO ACIDS

Arginine, ornithine, histidine, lysine, methionine, and phenylalanine are purported to have anabolic effects. Two studies reported that ingestion of arginine and ornithine in conjunction with strength training significantly increased body mass and decreased body fat compared to a placebo (Elam, 1988; Elam et al., 1989). However, body composition was only esti-

mated from skinfold measures, and diet was not controlled.

It is claimed that these amino acids stimulate a release of growth hormone and insulin, and thereby increase muscle mass (Jacobson, 1990; Kreider et al., 1993). Bucci et al. (1990;1992) gave bodybuilders 40, 100, or 170 mg/kg body weight of L-ornithine on three separate occasions, and although no increase in serum insulin was found, there was a significant increase in growth hormone after the 170-mg/kg dose (about 12-g ornithine for a 70 kg athlete). In the only study to use lower amino-acid doses and report a significant response, a single total dose of 1.2 g L-lysine plus 1.2 g L-arginine produced an increase in plasma growth hormone and insulin (Isidori et al., 1981).

Other studies have not supported these positive findings. Four days of dietary supplementation with a combination of L-arginine, L-ornithine, and L-lysine (2 g/d each) did not increase serum growth hormone and insulin (Fogelholm et al., 1993). When male bodybuilders ingested 2.4 g of an arginine/lysine supplement, a 1.85 g ornithine/tyrosine supplement, or a protein drink, there was no enhancement of growth hormone release (Lambert et al., 1993). Elite junior weight lifters who took an amino acid supplement (containing a variety of amino acids) during 1 wk of high-volume training, did not show an increase in resting or exercise blood levels of growth hormone, testosterone, or cortisol (Fry et al., 1993). Although Suminski et al. (1997) found that 1.5 g L-arginine and 1.5 g L-lysine increased serum growth hormone at rest, the increase was small (7.5 µg/l), transient, and highly variable among subjects. Ingestion of these amino acids prior to a bout of resistance exercise did not affect the growth-hormone response to exercise. In another study, 200 mg arginine/kg body weight did not increase serum growth hormone or influence weight loss, fat, lean tissue, or strength over 10 d (Walberg-Rankin et al., 1994).

Manufacturer-recommended doses of amino acid supplements are not likely to

increase growth hormone and alter body weight. Commercially available supplements contain less than 4 g per serving; higher levels of amino acids can cause mild-to-severe stomach cramps and diarrhea. These supplements are costly, and the consequences of using selected amino acids for a long period of time have not been determined. High amounts of one amino acid may affect the body's absorption of other amino acids. There is little reason at this time to believe that amino-acid supplements will promote gains in muscle mass.

SUMMARY

This paper reviewed chromium, creatine, vanadyl sulfate, boron, HMB, protein and amino acids supplements regarding their effectiveness as anabolic agents. Numerous other products on the market claim to build muscle mass, but there are not enough scientific studies of their efficacy in humans to present in this review. The weight of the data show that chromium is not effective in promoting gains in muscle mass. Creatine appears to increase body weight in some individuals. Early weight gain after creatine supplementation is most likely due to water retention in muscle, but long-term gains may also be partly due to increases in muscle protein synthesis. Research studies showed that boron and vanadyl sulfate do not increase muscle mass. HMB has been evaluated in one study and found to increase muscle mass and strength, and reduce muscle breakdown during resistance training. These data have not been adequately replicated and the mechanism to explain these effects is not yet clear.

The protein requirement of athletes during strength training is 1.4 to 1.8 g of protein · kg⁻¹ · d⁻¹ along with adequate energy; this protein can be obtained through the normal diet without protein supplements. Although "high tech" protein supplements include a variety of additives purported to boost weight gain, they have never been tested to evaluate their efficacy, and it seems unlikely they would be more effective than diet alone or a supplement such as casein (milk powder). Several formulations of

amino-acid supplements have been claimed to increase blood levels of growth hormone and insulin, thereby resulting in increased muscle mass, but studies have not systematically confirmed these effects.

Nutritional supplements are often advertised using deceptive and/or misleading claims. They can be marketed without the US Food and Drug Administration (FDA) review of safety or effectiveness, and many claims are unsubstantiated. The concentration of active ingredients can differ markedly from product to product due to the lack of regulatory control.

Studies of the effects of nutritional supplements on muscle mass have predominantly used male subjects. There is a lack of information on female responses to these supplements and on their effectiveness in individuals with different initial physiological status of the nutrient in question. Although some studies indicate that creatine and HMB may increase body weight, their effects on strength and performance remain unclear, the amount of gain is relatively small, and the results are yet to be adequately replicated. Nutritional supplements will not convert the 97-pound weakling into Charles Atlas. Moreover, nutritional supplements, even combined with strength training, will not give even Charles Atlas the physique of bodybuilders that grace the covers of today's "muscle" magazines.

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SUPER-DUPER WEIGHT GAIN SUPPLEMENT

This is a make-believe weight-gain supplement that is representative in many respects of products in this category of sports foods. This example is meant to serve as a teaching tool and not as a criticism of any specific product.

Nutrition Facts

Serving Size 1 packet (500 grams)
 Servings per container 1

Amount Per Serving 1 packet in water

Calories 1800

Calories from Fat 20

% Daily Value*

Total Fat—2g 4%

Saturated Fat—2g 10%

Cholesterol—40mg 14%

Sodium—420mg 18%

Potassium—800mg 24%

Total Carbohydrate—390g 130%

Dietary Fiber—2g 8%

Sugars—114g

Protein—54g

Vitamin A 70%

Vitamin C 70%

Calcium 60%

Iron 70%

Vitamin D 70%

Vitamin E 70%

Thiamin 70%

Riboflavin 70%

Niacin 70%

Vitamin B-6 70%

Folate 70%

Vitamin B-12 70%

Biotin 70%

Panthenic Acid 70%

Phosphorus 60%

Iodine 70%

Magnesium 70%

Zinc 70%

Copper 70%

COMMENT: This particular “weight-gain” supplement, when mixed with water, provides an additional 1800 calories daily. While the additional carbohydrate and protein calories will help to promote weight gain when combined with a proper strength and resistance program, these same nutrients (and many other ones) can be obtained by eating a balanced and varied diet.

The predominant ingredients found in this supplement are maltodextrins, whey protein concentrate, calcium caseinate, whey, nonfat dry milk, and egg white. Maltodextrins are short-chain carbohydrates, but these and more-complex carbohydrates can easily be obtained by eating foods rich in carbohydrate. Breads, cereals, grains, and vegetables supply complex carbohydrates and other nutrients such as B-vitamins, potassium, fiber (whole-grains) and even some protein. The remaining key ingredients in this supplement, whey, nonfat dry milk and egg whites, are merely extracts of cheese, milk, and eggs.

The vitamins and minerals included in this weight-gain supplement provide no added benefit. A balanced and nutritious diet with adequate calories will meet the athlete’s need for vitamins and minerals. Many high-carbohydrate foods are already fortified with vitamins (e.g. fortified cereals, breakfast bars, flour). This particular supplement contains several components without proven efficacy or safety records (i.e., guarana powder—a tropical plant with a high caffeine content; the amino acid ornithine; creatine—at a level less than 1% of a daily loading dose; royal jelly—a bee larvae food; a glandular blend containing liver and orchic-bull’s testes; and an enzyme mix that degrades during the digestive process. A meal comprised of a skinless chicken breast (4 oz), whole wheat bread (2 slices), a baked potato (1 medium), peas (1 cup), dried peaches (1 cup), iced angel food cake (1 slice), and fat-free milk with non fat dried milk powder (1 cup milk with 91g powder) provides roughly the same calories and key nutrients as one serving of this supplement at two-thirds of the cost, with the pleasure of eating a meal. Also, the chicken, milk, grains and vegetables in this meal combine to provide twice the protein content of the supplement 122 vs 54g. While this and similar weight gain supplements do not possess any magical properties, they provide an additional energy source for some athletes who may not be able to or wish to eat as much food as is required to keep pace with their energy needs.

INGREDIENTS: Maltodextrin (a source of complex carbohydrate). “Weight Gainer Superb Protein Mix” (whey protein concentrate, calcium caseinate, whey, nonfat dry milk, egg white protein), natural and artificial flavors, ornithine alphas-glutarate (150 mg), guarana powder (150 mg), creatine monohydrate (150 mg), Weight Gainer Superb Vitamin/Mineral Mix (potassium phosphate, calcium carbonate, magnesium oxide, vitamin E succinate, betaine hydrochloride, calcium ascorbate, ascorbic acid, beta-carotene, ferrous fumarate, boron citrate, niacinamide, L-malic acid, manganese gluconate, inositol, copper gluconate, riboflavin, L-carnitine, gamma oryzanol, sodium citrate, zinc oxide, calcium pantothenate, calcium succinate, inosine, alpha-ketoglutaric acid, choline bitartrate, para-aminobenzoic acid, thiamine mononitrate, vitamin D3, cyanocobalamin, folic acid, biotin, calcium iodate, chromium polynicotinate, sodium selenite, sodium molybdate, co-enzyme B12, royal jelly (25 mg), orchid (1500 mg) and liver (3000 mg), medium chain triglycerides, guar gum, soy lecithin, artificial color (caramel and red #40), enzyme mix (bromelain, papain, alpha-amylase, plant peptidase and protease).

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NUTRITIONAL SUPPLEMENT	PROMOTED USE/ CLAIM	RESEARCH AVAILABLE TO SUPPORT CLAIM	RECOMMENDED DIETARY ALLOWANCES (RDA)/ESTIMATED SAFE AND ADEQUATE DAILY DIETARY INTAKE (ESADDI) AND FOOD SOURCES OF SUPPLEMENT
Chromium - a trace mineral that works to potentiate the effects of insulin	Increase muscle, decrease fat, promote weight loss	While there are some data to support the claims, most research has not.	50-100 mcg. (ESADDI) Food sources: Instant oatmeal (10.3mcg/oz); russet potato (3.8 mcg/medium); peas (60 mcg/cup cooked); American cheese (60 mcg/oz); brewer's yeast (60 mcg/2T); pineapple slices (16.5 mcg/cup), beer (30-60 mcg/12oz)
Creatine - substance made by the body at a rate of approximately 1g/day. In the muscle, creatine combines with phosphate to form creatine phosphate, which is then involved in generating the primary fuel for the muscle, ATP.	Increase energy and muscular strength, burn fat, promote greater and quicker muscle gains beyond the body's natural capacities, improve endurance and delay the onset of fatigue	Some, but not all, studies have found that creatine ingestion improved short-term strenuous exercise performance. No long-term safety data are available.	There is no dietary requirement for creatine because it is synthesized by the body. Creatine is found in both meat and fish. A normal mixed diet provides about 1 gram of creatine per day. The usual 20-gram loading dose of creatine provides about as much creatine as 10 pounds of raw steak.
HMB (beta-hydroxy-beta-methyl-butyrate) - a metabolite of the branched-chain amino acid, leucine	Increase muscle mass by preventing protein breakdown and speeding the repair process	The only published study on humans reported that HMB (3 grams/day) increased muscle mass and strength and reduced muscle damage in weight training males.	There is no dietary requirement for HMB because it is synthesized by the body. HMB is found in low levels in grapefruit, catfish, and some other foods. Three grams of HMB is equivalent to 500 grams of meat (about 4 hefty hamburgers). A 10 day supply of HMB costs approximately \$25 (four-250 mg capsules taken 3 times per day).
Amino Acids - the building blocks for protein. There are 8 "essential amino acids" that must be provided by food and 9 "non-essential amino acids" that the body can synthesize from other components.	Arginine and ornithine, in particular, are touted to increase muscle mass by stimulating growth hormone and insulin.	While there are some data to support the claims, most research has not.	All of the necessary amino acids can be obtained from consuming the RDA for protein (1.4-1.8 g/kg with adequate calories for strength training athletes). The protein in foods (e.g., meats, dairy, beans, dried peas, eggs, grains) are broken down to their fundamental parts, amino acids, during digestion. Compare one cup of a low-fat fruited yogurt that contains 10 grams of high quality protein, 18 different amino acids (and 300 mg of arginine) carbohydrate, calcium, magnesium, and potassium to one tasteless 500 mg arginine supplement.

Hand-out created by Katie Fitzgerald, a dietetics student at Eastern Illinois University and Julie H. Burns, MS, RD of SportFuel, Inc.