

The SOY Connection

VOLUME 16, NUMBER 3



Health & Nutrition News About Soy

Summer 2008

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STUDIES SHOW SOY PROTEIN A COMPLEMENT TO EXERCISE

By Robert DiSilvestro, Ph.D.

Exercise contributes to many aspects of good health such as weight control, lowered risk of cardiovascular disease and a general feeling of well-being. If nutrition can influence exercise performance, training progress, appearance and sense of well-being during exercise (i.e. experiencing little or no soreness), then one may be encouraged to exercise longer and more regularly. Nutrition can directly heighten the effects of exercise on health. Some existing data suggest that soy protein intake can be one of the nutrition interventions that can complement an exercise program.

Soy protein as a food component could influence exercise performance and/or training effects from a number of perspectives: provision of high quality protein, furnishing of associated phytochemicals such as isoflavones, or by regulatory actions of peptides formed during digestion (though direct evidence for the latter effect remains mostly speculative).

A number of studies from our laboratory have shown that consumption of 40 g of soy protein per day for three to four weeks can enhance exercise recovery.¹⁻³ Such enhancement can speed training progress and inhibit muscle soreness. The studies published so far have focused on blood biochemical measures of inflammation, oxidant stress, and muscle tissue breakdown. In addition, unpublished work from our laboratory showed that soy protein intake partially blocked a post-resistance exercise increase in serum levels of the stress-related hormone cortisol.

One limitation of our studies on exercise recovery has been the emphasis on biochemical measures, not practical assessments such as muscle performance or feelings of soreness. To address this limitation, a study was done in men that included a three mile run the day following an unfamiliar, muscle stressing exercise session. This testing took place before and after a four-week intervention with a variety of soy protein types, a placebo or another protein. Most subjects showed no improvement in run performance, but nearly all the best improvers were in the group getting a high isoflavone soy protein (unpublished results). More work is needed on such practical effects of soy protein intake on exercise recovery.

In other work, a number of studies have shown that sustained soy protein intake can promote exercise-induced lean body mass gain.⁴⁻⁶ Similarly, feeding soy protein to rats after exercise stimulates muscle protein synthesis.⁷ In each of these studies, soy protein performed the same or similarly to whey protein—protein which has been traditionally touted for building muscle. If both soy and whey proteins

Continued on Page 2

IN THIS ISSUE:

- Protein and Athletic Performance, pg. 3
- Fueling Fitness, pg. 4
- Soybean Oil Corner, pg. 5



RESEARCH UPDATES

By Mark Messina, Ph.D.

IMPORTANCE OF CONSUMING SOY EARLY IN LIFE

The relationship between soy intake and breast cancer risk has been widely investigated for nearly two decades. The historically low Japanese breast cancer incidence rates and data showing soybean isoflavones possess chemopreventive properties provided the initial justification for this research. There have been many reviews of the soy and breast cancer

Continued on Page 2

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RESEARCH UPDATES

Continued from Page 1

relationship; however, most, if not all, have concluded that because of the conflicting data it is not possible to say with confidence that soy intake reduces breast cancer risk. To this point, a 2006 meta-analysis of the epidemiologic data by Trock et al.¹ that included 6 cohort and 12 case-control studies, found a small reduction in the risk of breast cancer associated with soy intake but a subanalysis revealed there were no protective associations in the studies involving Asians. It is the studies involving Asians that are most meaningful because soy intake among non-Asians is typically so low that any associations noted in epidemiologic studies are not likely to have a causal basis.

With this background in mind, the results of two epidemiologic studies published earlier this year are particularly revealing. One is a meta-analysis by Wu and colleagues from the University of California at Los Angeles.² This analysis included eight studies, all of which involved Asian subjects: seven were case-control studies and one a prospective study. In comparison to low-soy consumers, high soy intake was associated with a one-third reduction in the risk of both pre- and postmenopausal breast cancer. Women in the high-soy group consumed about 20 mg of soybean isoflavones (phytoestrogens) daily, the amount found in approximately one serving of a traditional soyfood. Isoflavone intake in the low-soy intake group was only about 5 mg/day. This analysis is particularly impressive because of the study inclusion/exclusion criteria. Importantly,

Continued on Page 6

SOY AS A COMPLEMENT TO EXERCISE

Continued from Page 1

perform equally, soy can provide some extra advantages beyond enhancement of muscle building. For example, in one of the lean body mass studies,⁴ soy intake prevented a training induced fall in blood antioxidant capacities and a rise in inflammation. Presumably, these preventative effects are largely due to soy isoflavones, which may have direct and indirect antioxidant and anti-inflammatory actions.^{1-3,8,9} The effects might also be due in part to peptides formed during soy protein digestion. Whatever the mechanisms, such effects can hold relevance for many well-being parameters such as cardiovascular health and immune system performance.

In contrast to studies showing comparable muscle building effects of soy versus other protein, a recent study found a different result.¹⁰ In novice, young male weight trainers, low fat milk consumed after exercise for a sustained training period promotes lean body mass better than soy protein. Two points should be noted. One, soy protein did promote lean mass gain. Two, as noted by the study authors, milk is more of a well-rounded food than isolated soy protein; thus, the milk advantage may result from non-protein nutrients such as calcium.

One might expect that the soy effects on lean body mass would also be associated with effects on muscle strength. In some cases, this expectation has been confirmed. For example, in one of the above noted studies on lean body

mass, soy protein also produced an increase in strength based on one repetition, maximal lifts.⁶ In an old, not very well controlled study on Romanian Olympic athletes, chronic intake of high isoflavone soy protein produced strength gain along with lean body mass gain.¹¹ Not all studies on soy and lean body mass show an association with increased strength. This finding should not come as a surprise. Typically, different types of strength measures show inconsistent patterns for studies of a single intervention, with different types of subjects, with different training patterns, and with different initial fitness states.

Besides the effects soy protein can have for exercise recovery and for training effects on muscle mass and strength, soy protein may be able to directly heighten the effects of exercise on health. Although this possibility has not yet been examined to any great extent, one attempt was made in regard to bone health in post-menopausal women.¹² Unfortunately, for the circumstances and soy protein dose examined in this study, soy protein intake plus exercise did not produce additive effects. A different design might yield different results since in a similar study in rats, exercise plus soy isoflavone intake does give additive effects on bone.¹³ The concept that soy protein may be able to increase health benefits of exercise needs to be expanded to consider other areas. These areas can include reducing cancer risk, strengthening

Continued on Page 3



The Soy Connection, funded by farmer checkoff dollars, is produced by the United Soybean Board for registered dietitians and select physicians. An electronic version of this newsletter, with complete references, can be found at www.soyconnection.com.

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SOY AS A COMPLEMENT TO EXERCISE

Continued from Page 2

of the immune system, cholesterol lowering and other aspects of cardiovascular health. Some hints that this can happen are already present. For example, a study from our laboratory was done with women who do aerobic exercise regularly.⁹ When the subjects consumed 40 g/d soy protein for four weeks, oxidative stress was reduced whereas no change was noted in the control group, which consumed whey protein. Such changes are thought to be relevant to a host of health issues including reduced risk of cancer

or atherosclerosis, strengthened immune system and blood pressure control. Despite these results, the study does not directly demonstrate that soy protein plus exercise produce better health benefits than either alone. This observation needs to be considered directly using intervention studies in a variety of age groups and circumstances.

Some male exercisers have avoided soy protein for fear that soy isoflavones may decrease testosterone concentrations. In contrast, our laboratory finds

that in male recreational runners, testosterone levels remained unchanged in response to the consumption of 40 g/d isoflavone-rich soy protein.¹⁴ As an indication of biological activity, soy protein intake raised plasma antioxidant capacities. This finding is consistent with the body of literature on this topic.⁵ 🍌

Complete references and author biographies for this and all articles can be found at www.soyconnection.com

PROTEIN AND ATHLETIC PERFORMANCE

By Wayne Campbell, Ph.D.

Proteins are constantly being synthesized and degraded, and on a daily to weekly basis the cumulative rates of protein synthesis and breakdown are in equilibrium, resulting in the maintenance of muscle and lean tissue mass. Resistance exercise and dietary protein intake promote muscle anabolism by increasing the rate of muscle protein synthesis while maintaining, or attenuating the increase in muscle protein degradation.^{1,2} The anabolic effects of resistance exercise and dietary protein are considered to be independent and additive, and muscle hypertrophy is theoretically achieved from the cumulative periods of positive protein balance.

Adequate dietary protein is important in promoting the maintenance of skeletal muscle mass. The current recommended dietary allowance (RDA) for protein is 0.8 g/kg body weight/d and is intended to be sufficient to meet the needs of nearly all (97.5%) healthy men and women age 19 years and older.³ For younger strength-trained athletes, an increased protein requirement may arise due to the additional protein required to support muscle growth through elevated protein synthesis.⁴ Studies which evaluated protein requirements for resistance-trained athletes determined the needs to be greater compared to sedentary persons.² However, it appears that any extra protein required by these individuals is directed towards muscle hypertrophy in the early phases of training when muscle mass is increasing. On the other hand, resistance-trained athletes who have a high but stable muscle mass likely do not have an increased protein requirement compared to sedentary persons. In fact, research suggests that resistance training may lead to biological adaptations that improve net protein retention, making the body more efficient in converting ingested protein into muscle protein.² Nitrogen balance analysis of persons participating in a rigorous strength training program showed that these individuals achieved nitrogen balance at a protein intake ~49% greater than the current RDA (1.19 g/kg body weight/d). Thus, after the initial adaptation

to a resistance training program, it appears that resistance-trained athletes would not have a markedly elevated protein requirement. However, this recommendation may be of little relevance since most resistance-trained athletes habitually consume protein intakes around 2.05 g/kg body weight/d, well above the recommendations.

The habitual consumption of adequate dietary protein is also important in the maintenance of skeletal muscle mass in older persons who are trying to offset the progression of sarcopenia. Evidence suggests that protein intakes above the RDA may enhance muscle hypertrophy in older persons that regular perform resistance training.¹ Campbell et al. (2007) recently conducted a retrospective reassessment of data from several diet and resistance training studies in men and women aged 50–80 years, with protein intakes ranging from 0.4 to 1.7 g/kg body weight/d. A modest, but significant positive relationship was found between dietary protein intake and fat-free mass changes, with the neutrality point on the regression line (no change in fat-free mass) at a protein intake of 1 g/kg body weight/d. Thus, consumption of the RDA for protein resulted in an apparent loss of fat-free mass, even with the anabolic stimulus of resistance training. These data suggest that the RDA for protein may be a marginally inadequate amount for older persons to habitually consume.

In summary, novice strength athletes may require modestly more dietary protein during the initial stages of a training program when muscle mass is increasing, compared to sedentary persons. However, during muscle mass maintenance, it appears that resistance-trained athletes would not have a markedly elevated protein requirement above the RDA of 0.8 g/kg body weight/d. Furthermore, in older persons who regularly perform resistance training, protein intakes moderately above the RDA may promote fat-free mass accretion and help slow the progression of and treat sarcopenia. 🍌

By Julie Jackson and Patricia Samour, M.M.Sc., R.D., L.D.N.

You know the feeling, halfway through your workout you hit the wall. Your legs feel like cement, you are lightheaded, your stomach is churning and your entire body feels fatigued. Whether it's first thing in the morning or after a long day at work, what you eat and drink before exercise can make or break your workout.

Eating before exercise can help prevent low blood sugar, settle your stomach, prevent hunger and fuel your muscles with glycogen so you are ready to move. Follow these simple guidelines to fuel your workout and perform your best.



Food

If you have three to six hours before you exercise, eat a meal containing complex carbohydrates like whole grain bread, bagels or baked potato, lean protein such as tofu, nut butters, lean beef or chicken, and healthy fats like soy, olive or canola oil.¹

Two to three hours before a workout may not be enough time for a meal, but a smaller "mini" meal can prevent hunger and fuel the body with glycogen, our muscles' primary energy source. Try foods containing carbohydrate and protein such as cereal with soy milk, a bagel with soy cheese or yogurt with granola.

One to two hours before exercise, ensure that your muscles are stocked with glycogen and you are ready for action with easy-to-digest, low-fat snacks that are rich in carbohydrates. Try soy chips, a granola bar, fruit or a sports bar. Avoid foods that are high in fiber or fat because these may cause indigestion during your workout.²

After exercise, refuel your body to promote recovery and maximize energy for your next workout. Your muscles replace their glycogen stores within the first few hours after your workout. Be sure to include some car-

bohydrates and protein to facilitate glycogen storage half an hour after the gym. Aim to consume about 0.5 grams of carbohydrate per pound of weight.³ Try half of a turkey and soy cheese sandwich or a smoothie made with soy milk.

Fluids

Proper hydration is also critical to maximize athletic performance. If you wait until you feel thirsty to hydrate, you have already lost more than a liter of fluid, and your workout may suffer.⁴ The best way to ensure that you are adequately hydrated is to drink water before, during and after exercise.

Drink 16 ounces (two cups) of fluid at least two hours before your workout.¹ This practice ensures that you will be well hydrated before you exercise and you will have enough time to excrete any excess fluid before you begin.

During exercise, drink eight to ten ounces every 15–20 minutes to replace fluids lost through sweat.² If it is hot or humid, drink even more to prevent dehydration. Drinking as much as your body can tolerate during exercise will keep you performing at your peak.

After exercise, be sure to replace all the fluid you may have lost. Weigh yourself before and after your workout, you will need to drink at least two cups (16 ounces) of fluid for each pound of weight lost.³

If your workout lasts longer than 60–90 minutes, consider sipping on a sports drink to replenish electrolytes and fluid that your body releases during exercise.

Peak performance is achieved when the body is nutritionally balanced and properly fueled. Experiment with different snacks and meals to find the right balance for your body, and get the most out of your next workout. 🍌

SOYBEAN OIL CORNER

SDA Soybeans: A New Sustainable Source of Omega-3 Fatty Acids

By Shawna L. Lemke, Ph.D.



Health authorities have recognized that diets should contain a sufficient amount of omega-3 fatty acids for protection from heart disease.¹⁻² The American Heart Association has recommended increased fish consumption to boost the currently low intake of the healthful long chain omega-3 fatty acids EPA and DHA;² however, daily consumption of fish and fish oil is not viewed as a sustainable long term source of omega-3 fatty acids³ and current availability and cost of these foods make them prohibitive to many segments of the population. There is a need for a land-based, sustainable source of omega-3 fatty acids that can be used in a wider range of foods to fit specific dietary habits and budgetary limitations.

Soybeans, canola and flax contain the omega-3 ALA; however, there is insufficient evidence to conclude that ALA promotes heart health than there is for the longer-chain omega-3 fatty acids.⁴ Furthermore, the fraction of ALA converted to EPA by humans ranges from only 0.2%⁵ to 7%,⁶ making ALA an inefficient precursor to the long chain omega-3 fatty acids.

Stearidonic acid (SDA, 18:4) is the omega-3 fatty acid produced by desaturation of ALA along the metabolic path to EPA and DHA in humans. SDA occurs in the food supply today (e.g., in some fish⁷ and plant oils⁸), but at relatively low levels when compared to ALA or EPA. Because SDA bypasses the rate-limiting step in the conversion of ALA to EPA and DHA, it is likely to produce more EPA in the body when consumed. Conventional soybean oil contains approximately 7% ALA, but soybeans lack the desaturation enzyme needed to make SDA, EPA or DHA. Through modern biotech-

nology, the gene for this enzyme has been successfully introduced, resulting in a soybean that produces oil containing ~20% SDA. The new soybean is expected to be commercially available within the next five years. Because of the broad use of soybean ingredients in the food supply, SDA soy-derived ingredients would make it possible to create many different omega-3 enriched foods.

James et al.⁹ conducted a study to determine the ability of ALA and SDA to increase red blood cell (RBC) concentrations of EPA and DHA in healthy human subjects. The study showed that to increase the RBC levels of EPA by the same amount as 1× EPA, it took about 14× ALA but only about 3× SDA. These results were confirmed in dogs.¹⁰ SDA as a component of various oils, including Echium oil, has been fed in other clinical studies, and enrichment of mononuclear cells and lipid fractions in EPA was also noted.¹¹⁻¹³ As expected from current understanding of the metabolic pathway, empirical evidence from these clinical and animal studies supports the conclusion that consumption of SDA leads to tissue enrichment of EPA.

Most clinical studies that provide strong evidence for reduced risk of death from cardiovascular disease have used fish or fish oil, which contain a mixture of EPA and DHA, therefore, it is not presently clear whether EPA or DHA is superior in this regard.¹⁴ The Japan EPA Lipid Intervention Study, however, provided strong evidence for cardioprotective effects of EPA alone.¹⁵ In this trial, over 18,000 hypercholesterolemic patients, all taking low-dose statins, were randomized to

1.8 g of EPA ethyl ester or usual care and were monitored for 4.5 years. There was a 19% reduction in the incidence of major adverse cardiac events observed in the EPA group ($p=0.01$).¹⁵ This finding underscores the importance of EPA and supports the rationale that SDA could be an important nutritional product because SDA converts to EPA significantly more efficiently than ALA as demonstrated in RBCs.⁹ The enrichment of RBCs with EPA and DHA has been shown to reflect cardiac membrane omega-3 fatty acid content. Expressed as a percentage of total fatty acids, this "Omega-3 Index" has been found to highly correlate with reduced risk of cardiovascular disease, particularly sudden cardiac death.¹⁶ These data combined with recommendations by health authorities to increase long chain omega-3 consumption support the nutritional value of SDA.

In summary, leading health authorities have concluded that omega-3 fatty acids are important for human health. Limitations of a sustainable supply of fish coupled with a high cost make fish oil an insufficient source of omega-3 fatty acids to the majority of the world's population. SDA soybean oil produced through biotechnology offers one potential sustainable solution to providing the health benefits of omega-3 fatty acids in foods acceptable to consumers with reasonable shelf life. 🍌

REFERENCES

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RESEARCH UPDATES

Continued from Page 2

only those studies that comprehensively assessed soy intake and that controlled for potential confounding variables were eligible. Past meta-analyses have used much less restrictive inclusion criteria.

In contrast to the results by Wu et al.² soy intake was found to be unrelated to the risk of breast cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC) study, which involved 37,643 British women.³ Ordinarily, the results from an epidemiologic study involving Western women would carry relatively little weight because of the low soy intake among non-Asians. However, the EPIC study over-sampled for individuals consuming meat-free diets. The median intakes for the high, medium, and low isoflavone intake groups were 0.2, 10.1, and 31.6 mg/d, respectively. Thus, isoflavone intake in this study was similar to that seen among Asians.

So how does one reconcile the contrasting results from the meta-analysis by Wu et al.² and the EPIC study?³ One biologically plausible explanation is that among Asians soy intake is protective because it reflects the fact that Asians who consume higher amounts of soy as adults also consumed higher amounts when young. Certainly, there is evidence that in general, childhood dietary behavior tracks into adulthood. In contrast, in the EPIC study, it is likely soy wasn't consumed when young because most of the vegetarians in that study probably adopted this way of eating only when they were older.

Thus, the results of these two studies, although conflicting, actually support the hypothesis that was first proposed in 1995, that soy intake during childhood and/or adolescence reduces breast cancer risk later in life. The lack of significant findings in the EPIC study are also consistent with the lack of effects noted in clinical studies that have examined the effects of soy intake on markers of breast cancer risk, such as breast tissue density and breast cell proliferation. Conversely, the protective associations noted in the Asian studies are consistent with animal studies showing soy and isoflavone exposure in young rodents reduces chemically-induced breast cancer. 🍓

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