The effects of a commercially available botanical supplement on strength, body composition, power output, and hormonal profiles in resistance-trained males

Chris Poole1, Brandon Bushey1, Cliffa Foster1, Bill Campbell2, Darryn Willoughby3, Richard Kreider4, Lem Taylor1, Colin Wilborn1*

Abstract

Background: Fenugreek (Trigonella foenum-graecum) is a leguminous, annual plant originating in India and North Africa. In recent years Fenugreek has been touted as an ergogenic aid. The purpose of this study was to evaluate the effects of Fenugreek supplementation on strength and body composition.

Methods: 49 Resistance trained men were matched according to body weight and randomly assigned to ingest in a double blind manner capsules containing 500 mg of a placebo (N = 23, 20 ± 1.9 years, 178 ± 6.3 cm, 85 ± 12.7 kg, 17 ± 5.6 %BF) or Fenugreek (N = 26, 21 ± 2.8 years, 178 ± 6 cm, 90 ± 18.2 kg, 19.3 ± 8.4 %BF). Subjects participated in a supervised 4-day per week periodized resistance-training program split into two upper and two lower extremity workouts per week for a total of 8-weeks. At 0, 4, and 8-weeks, subjects underwent hydrodensiometery body composition, 1-RM strength, muscle endurance, and anaerobic capacity testing. Data were analyzed using repeated measures ANOVA and are presented as mean ± SD changes from baseline after 60-days.

Results: No significant differences (p > 0.05) between groups were noted for training volume. Significant group x time interaction effects were observed among groups in changes in body fat (FEN: -2.3 ± 1.4%BF; PL: -0.39 ± 1.6 %BF, p < 0.001), leg press 1-RM (FEN: 84.6 ± 36.2 kg; PL: 48 ± 29.5 kg, p < 0.001), and bench press 1-RM (FEN: 9.1 ± 6.9 kg; PL: 4.3 ± 5.6 kg, p = 0.01). No significant interactions was observed among groups for Wingate power analysis (p = 0.95) or muscular endurance on bench press (p = 0.87) or leg press (p = 0.61). In addition, there were no changes among groups in any clinical safety data including lipid panel, liver function, kidney function, and/or CBC panel (p > 0.05).

Conclusion: It is concluded that 500 mg of this proprietary Fenugreek extraction had a significant impact on both upper- and lower-body strength and body composition in comparison to placebo in a double blind controlled trial. These changes were obtained with no clinical side effects.

Background

Fenugreek (Trigonella foenum-graecum) is a leguminous, annual plant originating in India and North Africa. It is an herbal product with many proposed health benefits found in the diets of various Middle Eastern countries and is now cultivated worldwide. The leaves and seeds of fenugreek are formulated to an extract or powder form for therapeutic application.

Fenugreek has been studied extensively in human and animal models. The effects of fenugreek supplementation on the regulation of insulin and hyperglycemia are well established. Defatted fractions of fenugreek seeds, high in fiber content and containing steroid saponins, lowered blood glucose and plasma glucagon concentrations after
eight days of consumption in dogs [1]. Other investigations utilizing human participants have implemented fenugreek supplementation (daily doses of 1 to 25 g/day) to diabetic patients eliciting positive glucose regulation responses [2,3]. Another study [4] examined the acute and chronic outcomes of a soluble dietary fiber (SDF) prepared from fenugreek seeds administered to type 1 and type 2 diabetic rats. After an oral glucose cocktail, SDF significantly offset blood glucose elevation in non-diabetic and diabetic (type 1 and 2) rats at 75 and 30 minutes post-consumption respectively. Following a 28 day SDF supplementation period, type 2 diabetic rats experienced a significant reduction (19%) in blood glucose levels, initiating a 1.5 fold increase in hepatic glyco-oxidative enzymes (ALT), and muscle and liver enzymes, red cells) and anabolic/catabolic hormones (free testosterone, cortisol, DHT, and estradiol) and metabolic hormones (insulin and leptin).

Methods
Experimental Approach to the Problem
The study was conducted as a double-blind, placebo controlled trial using parallel groups matched according to total body weight. The independent variable was the nutritional supplement Trigonella foenum-graecum. Dependent variables included: estimated dietary energy intake; body composition; upper and lower body 1-RM strength, muscle endurance (80% of 1RM), anaerobic sprint power, and fasting clinical blood profiles (substrates, electrolytes, muscle and liver enzymes, red cells, white cells) and anabolic/catabolic hormones (free testosterone, cortisol, DHT, and estradiol) and metabolic hormones (insulin and leptin).
nutritional supplements that may affect muscle mass (e.g., creatine, HMB) or anabolic/catabolic hormone levels (androstenedione, DHEA, etc) within six months prior to the start of the study (table 1).

Subjects were asked to maintain their normal dietary intake for the duration of the study and to refrain from ingesting any dietary supplement that contained potential ergogenic benefits. Subjects meeting eligibility criteria were informed of the requirements of the study and signed informed consent statements in compliance with the Human Subjects Guidelines of the University of Mary Hardin-Baylor and the American College of Sports Medicine.

**Entry and Familiarization Session**

Subjects believed to meet eligibility criteria were then invited to attend an entry/familiarization session. During this session, subjects signed informed consent statements and completed personal and medical histories. Subjects meeting entry criteria were familiarized to the study protocol via a verbal and written explanation outlining the study design. This included describing the training program, familiarizing the subjects to the tests to be performed, and practicing the bench press, leg press, and Wingate.

**Testing Sessions**

Following the familiarization/practice session, the subjects recorded all food and fluid intake on dietary record forms on four consecutive days preceding each experimental testing session in order to standardize nutritional intake. Dietary intake was assessed using the Food Processor Nutrition Software (ESHA, Salem, OR). Subjects were instructed to refrain from exercise for 48 hours and fast for 12-hours prior to baseline testing (T1). Subjects then reported to the Human Performance Lab for body composition and clinical assessments. Once reported to the lab, height was measured using standard anthropometry and total body weight was measured using a calibrated electronic scale (Health-o-meter®, Electromed Corp, Flint, MI) with a precision of +/-0.02 kg. Heart rate was determined by POLAR® (Finland) heart rate monitor. Blood pressure was assessed in the supine position after resting for 5-min using a mercurial sphygmomanometer via standard procedures.

Subjects then had body composition determined using hydrodensitometry using standard procedures. Subjects reported to the Human Performance Lab in swimsuits and had their body weight determined out of water by an electronic scale. Body composition was analyzed using an EXERTECH (La Crescent, MN) body density measuring system that utilizes a weighing platform with electronic (load cell) weighing system connected to a PC. Calibration is conducted daily by establishing linear interpolation from 2 known weights. Data points were recorded with data acquisition software from the force transducer. Residual volume was estimated using standard procedures [18]. Subjects were submerged in warm water and asked to exhale a maximal amount of air while a signal from the force transducer produced a readable analog wave. The most stable waveform was selected, and the mean value was recorded. Subjects performed this procedure until at least 2 trials were within a 0.10% difference or a total of 7 trials were completed. Next, body density was calculated after weight was recorded in and out of water, and the Siri equation was used to calculate percentage of body fat [19]. Fat-free mass (FFM) was also calculated from the percentage of body fat [20].

Subjects then donated approximately 20 ml of fasting blood using venipuncture techniques of an antecubital vein in the forearm according to standard procedures. Blood samples were shipped to Quest Diagnostics (Dallas, TX) to run clinical chemistry profile, hepatic function, and whole blood cell counts. Blood samples were also centrifuged and aliquoted to microcentrifuge tubes and stored at -40°C for future analyses. Serum samples were then assayed in duplicate for the hormones free testosterone, Insulin, leptin, cortisol (Diagnostics Systems Laboratories, Webster, TX), and dihydrotestosterone (DHT), estradiol (Alpco Diagnostics, Windham, NH), using enzyme-linked immunobosorbent assays (ELISA) and enzyme-immunolabsorbent assays (EIA) using a Wallac Victor-1420 microplate reader (Perkin-Elmer Life Sciences, Boston, MA), and the assays were performed at a wavelength or either 450 or 405 nm, respectively in the Exercise and Biochemical Nutrition Lab at Baylor University.

Subjects then performed 1 repetition maximum lifts (1-RM) on the isotonic bench press and leg press to assess strength and then muscular endurance. All strength/exercise tests were supervised by lab assistants experienced in conducting strength/anaerobic exercise tests using standard procedures. Subjects warmed-up (2 sets of 8 - 10 repetitions at approximately 50% of anticipated maximum) on the bench press. Subjects then performed successive 1-RM lifts starting at about 70% of

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**Table 1 Baseline characteristics of participants**

| Variable       | Group: FEN | Group: PLA |
|----------------|------------|------------|
| Age            | 21.4 ± 2.8 yr | 20.5 ± 1.9 yr |
| Height         | 178.1 ± 60 cm | 178.5 ± 65 cm |
| Weight         | 90.2 ± 18.2 kg | 85.7 ± 12.7 kg |
| Body Fat %     | 19.4 ± 8.4% | 16.3 ± 4.8% |

Abbreviations: FEN = fenugreek supplement group, PLA = placebo group
No significant differences (p > 0.05) between groups were observed.
anticipated 1-RM and increased by 5 - 10 lbs until the reaching a 1-RM. Subjects then rested for 10 minutes and warmed-up on the 45° leg press (2 sets of 8 - 10 repetitions at approximately 50% of anticipated maximum). Subjects then performed successive 1-RM lifts on the leg press starting at about 70% of anticipated 1-RM and increased by 10 - 25 lbs until reaching a 1-RM. Both 1-RM protocols were followed as outlined by the National Strength and Conditioning Association [21].

Following the strength assessments and 15 minutes of rest, subjects then perform a 30-second Wingate anaerobic capacity test using a Lode computerized cycle ergometer (Groningen, Netherlands). Cycle ergometer measurements (seat height, seat position, handle bar height, and handle bar position) were recorded and kept identical for each subject across testing sessions to ensure test to test reliability. Before leaving the lab, subjects were randomly assigned to a supplement group based on their body weight and given a training regimen. Subjects repeated all testing after 4 (T2) and 8 (T3) weeks of training and supplementation.

**Supplementation Protocol**

Subjects were matched into one of two groups according to total body weight. Subjects were then randomly assigned to ingest in a double blind manner capsules containing 500 mg of a placebo (PL) or Fenugreek (Torabolic (tm) Trigonella Foenum-Graecum) (standardized for 70% TRIGIMANNOSE) (FEN) (Indus Biotech, India). The dosages investigated represent the current recommended dosages sold in nutritional supplements. Subjects ingested the assigned capsules once per day in the morning on non-training days and prior to their workout on training days for 8-weeks. The supplements were prepared in capsule form and packaged in generic bottles for double blind administration by Indus Biotech. Supplementation compliance was monitored by research assistants by watching them take the supplements prior to supervised workouts and by having the subjects return empty bottles of the supplement at the end of 4 and 8 weeks of supplementation. Subjects reported to a research assistant on a weekly basis throughout the study to answer a questionnaire regarding side effects and health status.

**Training Protocol**

Subjects participated in a periodized 4-day per week resistance-training program, split into two upper and two lower extremity workouts per week, for a total of 8-weeks. This training regimen has shown to increase strength and lean body mass without additive dietary or supplementary interventions [22]. The subjects performed an upper body resistance-training program consisting of nine exercises (bench press, lat pull, shoulder press, seated rows, shoulder shrugs, chest flies, biceps curl, triceps press down, and abdominal curls) twice per week and a seven exercise lower extremity program (leg press, back extension, step ups, leg curls, leg extension, heel raises, and abdominal crunches) performed twice per week. Subjects performed 3 sets of 10 repetitions with as much weight as they can lift per set during weeks 1 thru 4 and performed 3 sets of 8 repetitions during weeks 5 thru 8, also with as much weight that could be lifted per set (typically 75-80% of 1RM). Rest periods between exercises lasted no longer than 3 minutes and rest between sets lasted no longer than 2 minutes. Training was conducted at the Mayborn Campus Center (MCC) at the University of Mary Hardin-Baylor under the supervision of trained research assistants, documented in training logs, and signed off to verify compliance and monitor progress. This training program has been shown to be a sufficient stimulus at inducing positive change in body composition and strength [22].

**Statistical Analysis**

Separate 2×3 (treatment × time) repeated measure ANOVAs were used to assess all data. In circumstances where sphericity within groups could not be assumed due to large within group variances, the Hunyks-Feldt epsilon correction factor was used to adjust within group F-ratios. For all significant group × time interactions and main effects, additional pair-wise comparisons were used to assess which time points yielded statistical significance between and within groups. Significance for all statistical analyses was determined using an alpha level of 0.05, and all data are presented as means ± standard deviations. All statistical procedures were analyzed using SPSS (Statistical Package for Social Science) version 16.0.

**Results**

**Medical Monitoring, Dietary Analysis, and Training Volume**

No subjects experienced any major clinical side effects related or unrelated to the study. However, several participants experienced gastrointestinal discomfort and/or mild stomach aches. All subjects completed the training protocol without any complications. Table 2 outlines all nutritional analyses data. No significant differences between groups (p > 0.05) were detected for total daily caloric intake, individual macronutrient intake, or training volume.

**Hematological Variables**

There were no significant group × time interactions or main effects (p > 0.05) for red blood cell count, white blood cell count, triglycerides, cholesterol variables, liver enzymes or proteins, markers of kidney function or muscle damage.
Body Composition
All body composition data are presented in table 3. Baseline total body weight was not significantly different ($p = 0.326$) between FEN and PL groups. There were no total body weight changes over the 8 week time course of the study between or within groups ($p > 0.05$). A significant main effect for time ($p = 0.004$) for lean body mass was observed, and further pair-wise comparisons revealed a significant increase in lean body mass for FEN at week 4 ($p < 0.001$) and week 8 ($p < 0.001$) compared with baseline. No such changes were noticed in PL group ($p > 0.005$).

Training Adaptations
Table 4 exhibits all training adaptation data. A significant group × time interaction ($p < 0.001$) and main effect for time ($p < 0.001$) was observed between FEN and PLA groups for bench press 1-RM, however pair-wise comparisons revealed no significant differences between FEN and PLA bench press 1-RM's at any time point. Pair-wise comparisons also showed significant increases in bench press 1-RM at week 4 ($p < 0.001$) and week 8 ($p < 0.001$) in comparison with baseline and from week 4 to week 8 ($p = 0.002$) in FEN. PLA experienced significant increases in bench press 1-RM at week 4 ($p = 0.008$) and week 8 ($p = 0.004$) when compared to baseline. A significant group × time interaction ($p < 0.001$) and main effect for time ($p < 0.001$) was observed between FEN and PLA groups for leg press 1-RM, as further pair-wise comparisons indicated a significant difference in FEN compared to PLA at week 8 ($p = 0.019$). Pair-wise comparisons also revealed significant increases in leg press 1-RM at week 4 (FEN: $p < 0.001$, PLA: $p < 0.001$) and week 8 (FEN: $p < 0.001$, PLA: $p < 0.001$) in comparison with baseline. No significant interactions or main effects ($p > 0.005$) were noted for muscular endurance repetitions on the bench press or leg press. A significant main effect for time ($p = 0.002$) was observed for wingate peak power, and further pair-wise comparison showed a significant increase in peak power for FEN at week 8 ($p = 0.008$). A significant

Table 2 Nutritional intake changes from baseline (T1) through week 8 (T3)

| Variable      | Group | Baseline (T1) | Week 4 (T2) | Week 8 (T3) | Between Group |
|---------------|-------|---------------|-------------|-------------|---------------|
| Total Calories| FEN   | 2213 ± 926    | 2350 ± 799  | 2228 ± 986  | $G = 0.375$   |
|               | PLA   | 2416 ± 916    | 2428 ± 850  | 3033 ± 1071 | $T = 0.323$   |
|               |       |               |             |             | $G \times T = 0.214$ |
| Carbohydrate (grams) | FEN   | 266 ± 163     | 280 ± 111   | 262 ± 142   | $G = 0.937$   |
|               | PLA   | 246 ± 110     | 245 ± 105   | 329 ± 176   | $T = 0.448$   |
|               |       |               |             |             | $G \times T = 0.268$ |
| Fat (grams)   | FEN   | 78 ± 40       | 82 ± 44     | 84 ± 55     | $G = 0.295$   |
|               | PLA   | 91 ± 34       | 96 ± 41     | 118 ± 38    | $T = 0.277$   |
|               |       |               |             |             | $G \times T = 0.505$ |
| Protein (grams) | FEN   | 116 ± 61      | 125 ± 57    | 105 ± 60    | $G = 0.772$   |
|               | PLA   | 120 ± 50      | 116 ± 32    | 133 ± 41    | $T = 0.964$   |
|               |       |               |             |             | $G \times T = 0.134$ |

Abbreviations: FEN = fenugreek supplement group, PLA = placebo group.

Symbols: † = Significant between group difference ($p < 0.05$), ‡ = Within group difference from baseline (T1), $p < 0.05$.

Table 3 Body composition changes within and between groups

| Variable     | Group | Baseline (T1) | Week 4 (T2) | Week 8 (T3) | Between Group |
|--------------|-------|---------------|-------------|-------------|---------------|
| Body Weight (kg) | FEN   | 90.2 ± 18.2   | 89.9 ± 18.2 | 90.4 ± 17.7 | $G = 0.305$   |
|              | PLA   | 85.7 ± 12.7   | 85.0 ± 13.9 | 85.8 ± 12.4 | $T = 0.244$   |
|              |       |               |             |             | $G \times T = 0.803$ |
| Lean Mass (kg) | FEN   | 157.7 ± 23.9  | 160.2 ± 23.8‡| 162.6 ± 22.9‡| $G = 0.640$   |
|              | PLA   | 157.2 ± 19.5  | 156.4 ± 22.4| 158.2 ± 19.5| $T = 0.004$†   |
|              |       |               |             |             | $G \times T = 0.057$ |
| Body Fat %   | FEN   | 19.4 ± 8.4    | 17.8 ± 8.4  ‡| 17.1 ± 8.6  ‡| $G = 0.298$   |
|              | PLA   | 16.3 ± 4.8    | 16.0 ± 4.8  | 15.9 ± 4.5  | $T < 0.001$†   |
|              |       |               |             |             | $G \times T < 0.001$† |

Abbreviations: FEN = fenugreek supplement group, PLA = placebo group.

Symbols: † = Significant between group difference ($p < 0.05$), ‡ = Within group difference from baseline (T1), $p < 0.05$. 

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http://www.jissn.com/content/7/1/34
interaction was detected for wingate mean power between FEN and PLA, but additional pair-wise comparison were unable to confirm any between or within group changes (p > 0.05).

Hormones
Hormonal data are presented in table 5. A significant group × time interaction effect over the eight week study period was detected for DHT concentrations, although pair-wise comparisons showed no between or within group changes (p > 0.05). A significant main effect for time was observed for leptin, however pair-wise comparisons displayed no within group changes over time for FEN or PLA. A significant main effect for group was noticed for free testosterone, as further pair-wise analyses revealed significant differences between FEN and PLA at week 4 (p = 0.018) and week 8 (p = 0.027). No significant between or within group changes occurred for any other serum hormone variables (p > 0.05).

Discussion
The major findings of this study suggest that ingesting 500 mg of a commercially available botanical extract once per day for eight weeks in conjunction with a structured resistance training program can significantly impact body composition and strength in resistance trained males when compared to a placebo.

It is well documented that a controlled resistance training program can positively influence body composition across multiple populations [23-28]. The PLA group decreased body fat percentage over the 8 week period void of any experimental treatment however, this reduction was not found to be statistically significant. In contrast, the FEN group experienced a significant reduction in body fat percentage losing 2.34% compared to only 0.39% in the PL group. This change in body fat percentage is likely related to the significant increase in lean body mass observed exclusively in the FEN group. Together, these findings imply that supplementing with 500 mg of the commercially available supplement combined with resistance training can alter body composition to a greater extent than resistance training alone for 8 weeks. Woodgate and Conquer [29] investigated the effects of consuming a daily stimulant-free supplement containing glucomannan, chitosan, fenugreek, G. sylvestre, and vitamin C in obese adults (age 20-50, BMI ≥ 30) while maintaining their normal dietary and exercise practices for six weeks. The experimental group significantly reduced their body fat percentage (-1.1% vs. 0.2%; p < 0.05) and absolute fat mass (-2.0 kg vs. 0.2 kg; p < 0.001) when compared with the placebo group. These results convey that the experimental proprietary blend significantly affected body composition more so than a placebo. The role that fenugreek alone played in altering body composition cannot be speculated, but in conjunction with glucomannan, chitosan, G. sylvestre, and vitamin C, fenugreek did assist in the reported changes. Together, the present study and the findings of Woodgate and Conquer [29] demonstrate that fenugreek supplementation has the potential to improve body

| Variable        | Group | Baseline (T1)  | Week 4 (T2)  | Week 8 (T3)  | Between Group |
|-----------------|-------|----------------|--------------|--------------|---------------|
| Bench Press     | FEN   | 105 ± 26       | 111 ± 27‡    | 114 ± 27‡    | G = 0.891     |
| 1RM (kg)        | PLA   | 107 ± 22       | 109 ± 22‡    | 111 ± 22‡    | T < 0.001†    |
|                 |       |                |              |              | G × T = 0.008†|
| Leg Press       | FEN   | 334 ± 74       | 384 ± 79‡    | 419 ± 87‡†   | G = 0.077     |
| 1RM (kg)        | PLA   | 316 ± 63       | 344 ± 66‡†   | 364 ± 68‡†   | T < 0.001†    |
|                 |       |                |              |              | G × T < 0.001†|
| Bench Press     | FEN   | 7.9 ± 1.9      | 7.6 ± 1.9    | 8.2 ± 1.8    | G = 0.091     |
| 80% to failure  | PLA   | 7.3 ± 1.5      | 7.0 ± 1.5    | 7.5 ± 1.7    | T = 0.154     |
|                 |       |                |              |              | G × T = 0.984|
| Leg Press       | FEN   | 12.2 ± 4.1     | 11.8 ± 3.8   | 10.8 ± 4.4   | G = 0.836     |
| 80% to failure  | PLA   | 12.0 ± 2.5     | 12.1 ± 2.8   | 11.3 ± 2.9   | T = 0.168     |
|                 |       |                |              |              | G × T = 0.821|
| Peak Power      | FEN   | 1141 ± 222     | 1161 ± 198   | 1183 ± 200‡  | G = 0.428     |
| (watts)         | PLA   | 1091 ± 215     | 1115 ± 231   | 1132 ± 237   | T = 0.002†    |
|                 |       |                |              |              | G × T = 0.974|
| Mean Power      | FEN   | 628 ± 96       | 640 ± 107    | 643 ± 103    | G = 0.363     |
| (watts)         | PLA   | 616 ± 90       | 609 ± 95     | 611 ± 85     | T = 0.507     |
|                 |       |                |              |              | G × T = 0.036†|

Abbreviations: FEN = fenugreek supplement group, PLA = placebo group.
Symbols: † = Significant between group difference (p < 0.05), ‡ = Within group difference from baseline (T1), p < 0.05, = Within group difference from week 4 (T2).
composition, specifically body fat percentage, over a chronic time period, although the mechanism of action has not been elucidated.

Strength increases resulting from a resistance training regimen are well established [24,30-35]. Initial strength changes occurring in untrained populations are attributable to neural adaptations [36,37], while individuals that have neurally adapted can experience hypertrophic changes that occur in a matter of weeks to months after the onset of resistance training [38]. In the present study, we employed an eight week, linear resistance training program that has established itself as an efficient stimulus for increasing muscular strength and lean muscle mass (hypertrophy) [22]. Over the course of eight weeks, the PL group significantly increased bench press (4.22%) and leg press (15.26%) 1-RM strength, indicating the resistance training program alone augmented upper- and lower-body maximal strength. The FEN group experienced a 9.19% increase in bench press 1-RM, but this increase was not influenced by the experimental treatment. In spite of this, the FEN group experienced an increase in bench press 1-RM from T1 to T2 and T2 to T3, while PLA only increased from T1 to T2. Based on this finding, it is possible that fenugreek can positively affect performance measures, such as those analyzed in the present study, over longer periods of time (8+ weeks).

Significant differences were observed between FEN and PL groups at T3 for leg press 1-RM, as FEN underwent a 25.29% increase. No significant changes were observed for bench press or leg press muscular endurance tests or Wingate mean power. To our knowledge, there have been no investigations examining the effects of a dietary supplement containing fenugreek on muscular strength. However, one particular inquiry [39] evaluated the effects of two different dosings (10 mg/kg or 35 mg/kg) of galactomannan treatment, in comparison to testosterone treatment (10 mg/kg), on levator ani muscle weight in male castrated rats. At the end of six weeks, 35 mg/kg of galactomannan was as effective as the testosterone treatment at increasing the levator ani muscle and overall body weight in rats. An increase in a muscle’s weight is reflective of muscle hypertrophy or an increase in the cross sectional area of muscle fibers. There is a direct relationship between a muscle’s cross sectional area and overall strength of that particular muscle [40]. Therefore, if the levator ani muscle increased in cross sectional area, the possibility exists that a strength increase accompanied this adaptation, even though there were no strength measurements assessed in this study. The results from the present study suggest that 500 mg of a commercially available supplement can increase overall body strength during an 8 week period, or potentially over a more chronic time frame, in resistance trained males, and there is a possibility that a high dosage of a treatment (galactomannan) can increase muscle strength via muscle hypertrophy in

| Variable     | Group | Baseline (T1) | Week 4 (T2) | Week 8 (T3) | Between Group |
|--------------|-------|---------------|-------------|-------------|---------------|
| Estrogen (pg/ml) | FEN   | 102 ± 67      | 107 ± 55    | 109 ± 60    | G = 0.196     |
|              | PLA   | 83 ± 32       | 83 ± 31     | 91 ± 32     | T = 0.173     |
| Cortisol (mg/dl) | FEN   | 75 ± 23       | 77 ± 27     | 74 ± 28     | G = 0.805     |
|              | PLA   | 88 ± 80       | 60 ± 21     | 85 ± 85     | T = 0.418     |
| Insulin (uIU/mL) | FEN   | 15 ± 8        | 13 ± 6      | 15 ± 8      | G = 0.299     |
|              | PLA   | 15 ± 10       | 17 ± 10     | 16 ± 9      | T = 0.962     |
| Leptin (uIU/mL) | FEN   | 15 ± 14       | 13 ± 14     | 19 ± 16     | G = 0.974     |
|              | PLA   | 14 ± 11       | 16 ± 12     | 17 ± 12     | T = 0.044†    |
| Free Testosterone (ng/ml) | FEN   | 40 ± 33       | 33 ± 22     | 36 ± 22     | G = 0.020†    |
|              | PLA   | 57 ± 47       | 66 ± 53†    | 67 ± 54†    | T = 0.829     |
| DHT (pg/ml) | FEN   | 1263 ± 496    | 1152 ± 466  | 1144 ± 447  | G = 0.921     |
|              | PLA   | 1187 ± 482    | 1156 ± 448  | 1258 ± 493  | T = 0.134     |

Abbreviations: FEN = fenugreek supplement group, PLA = placebo group.
Symbols: † = Significant between group difference (p < 0.05).
Fenugreek supplementation is surrounded by assertions of having anabolic potential, even though there is no scientific data supporting this notion. In the present study we examined serum hormone variables that included free testosterone, DHT, estradiol, insulin, cortisol, and leptin over an eight week period. Of the above listed, no between or within group differences were observed for any of the measured hormone variables, except for free testosterone. Although a between group difference was noted for free testosterone at T2 and T3, it has limited relevance due to the fact that it did not significantly change over time. The investigation by Aswar and colleagues (2008) found no significant changes in serum testosterone levels in rats when treated with either a 10 mg/kg or 35 mg/kg dosage of galactomannan. This evidence coincides with our findings, which implies that the commercially available supplement lacks the potential for altering hormone values in combination with a resistance training regimen. Therefore, it is assumed that daily consumption of the 500 mg commercially available supplement in conjunction with a resistance training program has no anabolic effect on the hormonal status of resistance trained males.

Conclusions
Based on the results of the study, we conclude that daily consumption of 500 mg of the commercially available fenugreek supplement (Torabolic(tm)) in conjunction with an eight week, structured resistance training program can significantly increase upper- and lower-body strength, reduce body fat percentage, and improve overall body composition when compared to a placebo group under identical experimental protocols. The mechanisms responsible for these changes are not clearly understood due to the limited amount of research regarding fenugreek’s potential for influencing anaerobic exercise performance and hormonal changes in animal as well as human populations. The commercially available supplement non-significantly impacted muscular endurance, hormonal concentrations and hematological variables. Future research might investigate different extractions and dosages of fenugreek on trained populations to determine if anabolic hormones can be altered and to ascertain if further strength and power output adaptations are possible that could ultimately enhance exercise performance.

Acknowledgements
This work was funded by Indus Biotech. We thank all participants and staff of the HPL for their contributions to this work.

Author details
1 Human Performance Lab, Department of Exercise and Sport Science, University of Mary Hardin-Baylor. Belton, Texas, 76513, USA. 2 Exercise and Performance Nutrition Lab, School of Physical Education and Exercise Science, The University of South Florida, USA. 3 Exercise and Biochemical Nutrition Laboratory, Department of Health, Human Performance & Recreation, Baylor University, Waco, TX 76798, USA. 4 Exercise and Sport Nutrition Laboratory, Department of Health and Kinesiology, Texas A&M University, College Station, TX 77843, USA.

Authors’ contributions
CW is the principal investigator. CP & BB assisted in data collection and coordinated the study. CP, CW, & LT analyzed data & wrote the manuscript. RK assisted in the grant preparation and securing grant funding. DW & LT analyzed blood variables. BC, LT, & CF consulted on study design, manuscript review and preparation. All authors have read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

Received: 31 August 2010 Accepted: 27 October 2010
Published: 27 October 2010

References
1. Valette G, Sauvage Y, Baccou JC, Ribes G: Hypcholesterolaeic effect of fenugreek seeds in dogs. Atherosclerosis 1984, 50:105-111.
2. Gupta A, Gupta R, Lal B: Effect of Trigonella foenum-graecum (fenugreek) seeds on glycemic control and insulin resistance in type 2 diabetes mellitus: a double blind placebo controlled study. J Assoc Physicians India 2001, 49:1057-1061.
3. Raghuram TC, Sharma BD, Sivakumar B: Effect of fenugreek seeds on intravenous glucose disposition in non-insulin dependent diabetic patients. Phytoter Res 1994, 8:83-86.
4. Hannan JM, Ali M, Roykae B, Khaleque J, Akhter M, Flatt PR, Abdel-Wahab TH: Soluble dietary fibre fraction of Trigonella foenum-graecum (fenugreek) seed improves glucose homeostasis in animal models of type 1 and type 2 diabetes by delaying carbohydrate digestion and absorption, and enhancing insulin action. Br J Nutr 2007, 97:S14-S21.
5. Talpur N, Echard B, Ingram C, Bagchi D, Preuss H: Effects of a novel formulation of essential oils on glucose-insulin metabolism in diabetic and hypertensive rats: a pilot study. Diabetes Obes Metab 2005, 7:195-199.
6. Wajakumar MIV, Singh S, Chhipa RR, Bhat MK: The hypoglycaemic activity of fenugreek seed extract is mediated through the stimulation of an insulin signalling pathway. Br J Pharmacol 2005, 146:41-48.
7. Ajabnoor MA, Tilmisany AK: Effect of Trigonella foenum-graecum on blood glucose levels in normal and alloxaan-diabetic mice. J Ethnopharmacol 1988, 22:45-49.
8. Pipelzadeth MH, Dezfukian A, Koochek MH, Moradi M: Comparison between fenugreek and lovastatin in restoration of endothelial function in an experimental old rat model. Acta Medica Iranica 2003, 41:84-90.
9. Stark A, Madar Z: The effect of an ethanol extract derived from fenugreek (Trigonella foenum-graecum) on bile acid absorption and cholesterol levels in rats. Br J Nutr 1993, 69:277-287.
10. Venkataraman N, Devanaj SN, Devanaj H: Increased binding of LDL and VLDL to apo B, E receptors of hepatic plasma membrane of rats treated with Fibrinect. Eur J Nutr 2003, 42:262-271.
11. Olivecrona G, Olivecrona T: Triglyceride lipases and atherosclerosis. Curr Opin Lipidol 1995, 6:291-305.
12. Raju J, Bird RP: Alleviation of hepatic steatosis accompanied by modulation of plasma and liver TNF-alpha levels by Trigonella foenum-graecum (fenugreek) seeds in Zucker obese (fa/fa) rats. Br J Obes (Ecat) 2006, 30:1298-1307.
13. Kavianesam S, Ramamurthy N, Gunasekaran P, Varalakshmi E, Anuradca CV: Fenugreek (Trigonella foenum-graecum) seed extract prevents ethanol-induced toxicity and apoptosis in Chang liver cells. Alcohol Alcohol 2006, 41:267-273.
14. Al-Wabel NA, Mousa HM, Omer OH, Abdel-Salam AM: Biological evaluation of aqueous herbal extracts and stirred yoghurt filtrate mixture against alloxaan-induced oxidative stress and diabetes in rats. International Journal of pharmacology 2008, 4:135-139.

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http://www.jissn.com/content/7/1/34
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The effects of a commercially available
[Experimental study of the anabolic activity of 6-
Body composition from fluid spaces and density: analysis of
et al
Adaptations to Anaerobic Training Programs.
The effects of maximal resistance training on the
15
Effect of resistance training volume on strength and
7
64
1974,
48
2003,
27
53
et al
Effects of a Stimulant-Free Dietary
Current Therapeutic Research
1974,
Effects of three resistance training programs on
J Strength Cond Res
1993,
J Gerontol A Biol Sci Med Sci
1999,
29
18
9
Influence of exercise and training on motor unit activation.
3
57x98
38. Staron RS, Karapondo DL, Kraemer WJ, Fry AC, Gordon SE, Falkel JE,
37. Sale DG:
36. Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P:
35. Starkey DB, Pollock ML, Ishida Y, Welsch MA, Brechue WF, Graves JE,
34. Morganti CM, Nelson ME, Fiatarone MA, Dallal GE, Economos CD,
33. Hagerman FC, Walsh SJ, Staron RS, Hikida RS, Gilders RM, Murray TF,
32. Faigenbaum AD, Westcott WL, Loud RL, Long C:
31. Chilibeck PD, Calder AW, Sale DG, Webber CE:
30. Anderson T, Kearney JT:
29. Woodgate DE, Conquer JA:
28. Nichols JF, Omizo DK, Peterson KK, Nelson KP:
27. Mayhew JL, Gross Gross PM:
26. Kemmler WK, Lauber D, Engelke K, Weineck J:
25. Joseph LJ, Davey SL, Evans WJ, Campbell WW:
24. Brown CH, Wilmore JH:
23. Broeder CE, Burhns KA, Svanevik LS, Volpe J, Wilmore JH:
22. Kerksick CM, Wilborn CD, Campbell BI, Roberts MD, Rasmussen CJ,
21. Baechle TR, Earle RW, (Ed): Essentials of Strength Training and
Conditioning, Human Kinetics, 3 2008.
20. Siri WE:
19. Siri WE:
18. Quanjer PH:
17. Syrov VN, Kurmukov AG:
16. Urmila Aswar VM, Bhaskaran S, Bodhankar LS:
15. Ikeuchi M, Yamaguchi K, Koyama T, Sono Y, Yazawa K:
14. Androgenic and Anabolic Activity in Male Rats. Pharmacology Online
2008, 56-65.
13. Syrov VN, Kurmukov AG: [Experimental study of the anabolic activity of 6-
12. Starke DB, Pollack ML, Ishida Y, Welch MA, Brechue WF, Graves JE,
11. Feigenbaum AD, Westcott WL, Loud RL, Long C: Effects of single- vs.
multiple-set resistance training on maximum strength and body
composition in trained postmenopausal women. J Strength Cond Res
2004, 18:689-694.
10. Mayhew JL, Gross Gross PM: Body composition changes in young women
with high resistance weight training. Res Q 1974, 45:433-440.
9. Nichols JF, Omizo DK, Peterson KK, Nelson KP: Efficacy of heavy-resistance
training for active women over sixty: muscular strength, body
composition, and program adherence. J Am Geriatr Soc 1993, 41:205-210.
8. Woodgate DE, Conquer JA: Effects of a Stimulant-Free Dietary
Supplement on Body Weight and Fat Loss in Obese Adults: A Six-Week
Exploratory Study. Current Therapeutic Research 2004, 64:248-262.
7. Anderson T, Kearney JT: Effects of three resistance training programs on
muscular strength and absolute and relative endurance. Res Q Exerc Sport
1982, 53:1-7.
6. Chilibeck PD, Calder AW, Sale DG, Webber CE: A comparison of strength
and muscle mass increases during resistance training in young women.
Eur J Appl Physiol Occup Physiol 1998, 77:170-175.
5. Faigenbaum AD, Westcott WL, Low RL, Long C: The effects of different
resistance training protocols on muscular strength and endurance
development in children. Pediatrics 1999, 104:e5.
4. Hagerman FC, Walsh SJ, Staron RS, Hikida RS, Gilders RM, Murray TF,
Toma K, Ragg KE: Effects of high-intensity resistance training on
untrained older men. I. Strength, cardiovascular, and metabolic
responses. J Gerontal A Biol Sci Med Sci 2000, 55:S336-S346.
3. Morganti CM, Nelson ME, Fiatarone MA, Dallal GE, Economos CD,
Crawford BM, Evans WJ: Strength improvements with 1 yr of progressive
resistance training in older women. Med Sci Sports Exerc 1995, 27:906-912.
2. Starke DB, Pollack ML, Ishida Y, Welch MA, Brechue WF, Graves JE,
Feigenbaum MS: Effect of resistance training volume on strength and
muscle thickness. Med Sci Sports Exerc 1996, 28:1311-1320.
1. Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P:
Increased rate of force development and neural drive of human skeletal
muscle following resistance training. J Appl Physiol 2002, 93:1318-1326.
0. Sale DG: Influence of exercise and training on motor unit activation.
Exerc Sport Sci Rev 1987, 15:95-151.