A MULTI-INGREDIENT PRE-WORKOUT SUPPLEMENT AND EXERCISE DURATION ACUTELY AFFECTED MUSCLE SIZE AND QUALITY FOLLOWING HIGH-INTENSITY FUNCTIONAL TRAINING

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INTRODUCTION

High-intensity functional training (HIFT) often combines traditional aerobic, resistance training, and gymnastic modalities into circuit-style workouts meant to elicit adaptations across multiple fitness domains (2, 7). Workout performance is typically judged by how fast work is completed. This necessitates a sustained ability to supply nutrients (e.g., oxygen, glucose, fatty acids) to working muscle (5, 7). This ability might be observed through acute changes in muscle size and quality (9). Enhanced blood flow could be seen through acute increases in muscle size, whereas transient changes in quality might reflect the presence of energy substrate and other nutrients.

Pre-workout formulations often include nitric oxide (NO) precursors (L-Citrulline, Beet Root Extract, Red Spinach Extract). These are thought to facilitate blood flow to working muscles (3) along with caffeine, taurine, ancient peat and apple fruit extract that assist with energy availability (4, 6, 8). No study has investigated the effect of any pre-workout formulation on blood flow to exercising musculature following a bout of HIFT.

Previously, the Maximum Pre-workout (Shifted LLC, Eugene, OR) formulation (see Table 1) did not affect subjective measures of "muscle pump" following five sets of bench press and bent-over row (1). However, performance in either of these activities is not highly dependent on sustained energy availability and subjective assessment lacks precision.

PURPOSE

To examine the acute effect of a pre-workout supplement and exercise duration on muscle cross-sectional area and quality.

METHODS

Men and women (n=20: 29±8 years, 172±8 cm, 81±15 kg) with HIFT experience (≥2 years) completed four randomized visits in a crossover fashion after fasting 2-3 hours, once per week, over 4 consecutive weeks at their usual workout time.

Ultrasound (General Electric LOGIQ S7 Expert) assessments prior to physical activity and immediately post-exercise to quantify changes in quadriceps cross-sectional area (CSA) and echo intensity (EI), as proxies for blood flow and muscle quality (9).

Following pre-exercise ultrasound, participants consumed either the pre-workout supplement (S) or non-caloric placebo (P), rested 40-minutes, and then randomly completed either a 5- or 15-minute workout (see Figure 1).

Figure 1. Workout Design

Following a standardized warm-up, participants completed a circuit of rowing (men: 9kcal; women: 7kcal), six barbell thrusters (men: 43.1kg; women: 29.5kg), and three box jumps (men: 0.6m; women: 0.5m) for '*as many reps as possible*' (AMRAP). Movement standards were adopted from (2).

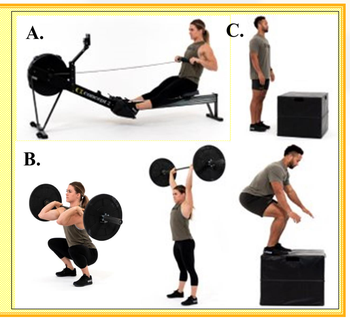


Table 1. Supplement ingredient list

Serving Size: 1 scoop (30 g)

Ingredients	Amount per serving	% DV
Calories	5	
Total Carbohydrate	1 g	<1%*
Niacin (as Nicotinic Acid)	15 mg	94%
Vitamin B6 (as Pyridoxine HCl)	1 mg	59%
Vitamin B12 (as Methylcobalamin)	100 mcg	4167%
Iron	1 mg	6%
Magnesium (from Red Spinach Leaf Extract and Dimagnesium Malate)	9 mg	2%
Sodium (as Pink Himalayan Sea Salt)	40 mg	2%
Potassium (from Red Spinach Leaf Extract and Potassium Chloride)	248 mg	5%
L-Citrulline	8 g	**
Creatine Monohydrate	5 g	**
Taurine	3 g	**
Beta-Alanine (as CarnoSyn®)	2.5 g	**
Betaine Anhydrous	2.5 g	**
L-Tyrosine	2 g	**
Red Spinach Leaf Extract (as Oxystorm®)	1 g	**
Beet Root Extract	1 g	**
Alpha-GPC (Alpha-Glycerol Phosphoryl Choline 50%)	300 mg	**
Caffeine Blend Caffeine Anhydrous (250 mg) zümXR® Delayed Release Caffeine (50 mg)	300 mg	**
L-Theanine	150 mg	**
ElevATP® (Ancient Peat and Apple Fruit Extract)	150 mg	**
Pink Himalayan Sea Salt	100 mg	**
Rhodiola rosea (root) Extract	100 mg	**
Co-Enzyme Q10	25 mg	**
AstraGin® [Astargalus membranaceus (root) Extract & Panax notoginseng (root) Extract]	25 mg	**
BioPerine® (Black Pepper Fruit Extract)	5 mg	**

*Percent Daily Values (DV) are based on a 2,000-calorie diet
** Daily value not established

OTHER INGREDIENTS: Citric acid, Natural Flavor, Calcium Silicate, Malic Acid, Silicon Dioxide, Sucralose, Spirulina Powder

RESULTS

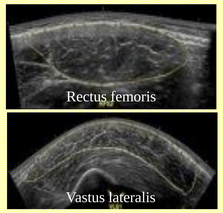
Separate repeated measures analysis of variance revealed significant condition x time interactions for CSA and EI in both muscles. Except for vastus lateralis CSA, no differences were seen pre-exercise. An ~8.8 – 11.7% greater post-exercise increase in CSA of both muscles ($p < 0.05$) was seen in both S workouts compared to both P workouts (see Figure 2). Greater ($p < 0.05$) post-exercise EI was seen during 5S compared to 5P (see Figure 3). A significant condition x sex interaction ($p < 0.05$) was noted for EI (both muscles), where between condition differences at the same workout duration were seen in women but not men. In women, greater post-exercise EI ($p < 0.05$) was seen following 5S compared to 5P, whereas the reverse ($p < 0.05$) was seen between 15S and 15P (see Table 2).

Table 2. Changes in quadriceps echo intensity

		Rectus femoris		Vastus lateralis	
		Pre-exercise	Post-exercise	Pre-exercise	Post-exercise
Women	5-minute workout				
	Placebo	84.3 ± 18.3	84.7 ± 19.8	86.6 ± 20.7	89.3 ± 19.1
	Supplement	**91.7 ± 25.6**	**98.8 ± 24.3 ***	**97.6 ± 24.3**	**101.9 ± 23.2***
	15-minute workout				
	Placebo	94.2 ± 24.4	99.5 ± 23.6	102.5 ± 22.8	105.6 ± 22.3
	Supplement	**84.9 ± 22.1**	**91.0 ± 24.6 ***	**88.6 ± 17.5**	**94.7 ± 18.4***
Men	5-minute workout				
	Placebo	99.2 ± 15.8	100.3 ± 16.5	99.2 ± 15.8	97.0 ± 16.0
	Supplement	96.9 ± 14.6	101.0 ± 18.6	95.7 ± 15.7	98.7 ± 18.6
	15-minute workout				
	Placebo	99.7 ± 18.6	104.0 ± 19.5	97.0 ± 17.1	102.1 ± 19.6
	Supplement	101.0 ± 12.9	106.7 ± 17.2	97.9 ± 12.1	102.0 ± 14.8

* = Significantly ($p < 0.05$) different from placebo

Figure 2. Ultrasound (General Electric LOGIQ S7 Expert) was used to quantify changes in quadriceps CSA as an estimate of blood flow. * = Significantly ($p < 0.05$) different from placebo at the same time point and workout duration; † = Significantly ($p < 0.05$) different from PRE.



Ultrasound images analyzed on personal computer via Image J (v 1.45s; National Institute of Health)

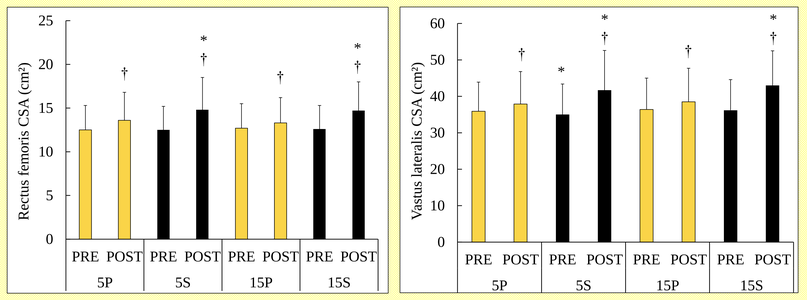
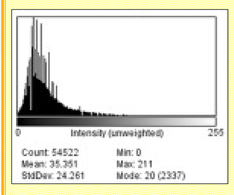
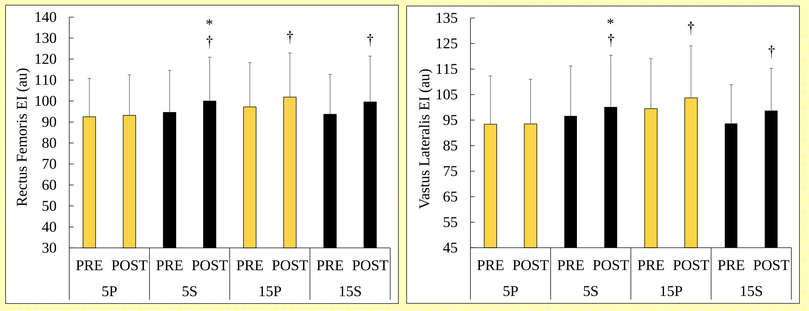


Figure 3. Ultrasound (General Electric LOGIQ S7 Expert) was used to assess changes in quadriceps echo intensity as a proxy for muscle quality. * = Significantly ($p < 0.05$) different from placebo at the same time point and workout duration; † = Significantly ($p < 0.05$) different from PRE.





CONCLUSIONS

The supplement led to a greater increase in CSA compared to placebo. This contrasts the findings of Beyer et al., (2024), who subjectively assessed muscle pump following five sets of bench press. The present study utilized a more objective assessment following exercise that would have required greater blood flow and nutrient availability to exercising muscle (5).

The supplement affected post-exercise EI, but this was modulated by workout duration and sex. The reasons for this are currently unclear, but it may have to do with the lack of precision of EI. Ultrasound assessment of EI might represent changes in nutrient availability, as well as changes in muscle quality, damage, and cell swelling (9).

PRACTICAL APPLICATION

The data suggests that the pre-workout supplement used in this study may enhance blood flow to working muscle and potentially alter nutrient availability during a bout of high-intensity functional training.

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