

THE EFFECT OF β -ALANINE (CARNOSYN™) SUPPLEMENTATION ON MUSCLE CARNOSINE SYNTHESIS DURING 4 WEEKS USING A ONE-LEG TRAINING MODEL

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ABSTRACT

Carnosine (Carn) is highly effective in buffering H⁺ over the physiological pH range and is probably the only such compound in muscle where the concentration can be changed by diet (or training). Synthesis occurs in muscle from β -alanine (β -Ala) and histidine and can be increased by β -Ala supplementation. Muscle Carn can also be increased by chronic training (Parkhouse *et al* 1985; Tallon *et al* 2005). The effect of short-term training is less clear. Suzuki *et al* (2004) reported a doubling in the concentrations with 8 wk sprint training (3d/wk) in contrast to Mannion *et al* (1994) where no effect of 16 wk isokinetic training (3d/wk) was found. **Aim** To investigate the effect of β -Ala supplementation on muscle Carn synthesis during 4 wk using a one-leg training model. **METHOD** Study a): 14 male Vietnamese PE students aged 20-26yr of normal body-mass and height participated. None were vegetarians. Their normal dietary intake of meat and fish was estimated to contribute 200-600 mg/d β -Ala (in dipeptide form). Subjects were matched according to body-mass and initial strength, and randomised to receive 800mg x 8/d x 4wk of β -Ala (Carnosyn™, NAI, San Marcos) or matching placebo capsules of maltodextrin. Subjects trained isokinetically using one designated leg (T) 3/wk during wks 1-2 and 4/wk during wks 3-4. Each training session consisted of 10x10 maximum 90° isokinetic knee extension and flexion contractions @ 180°/s using a KinKom isokinetic dynamometer, with 1 min rest between bouts. The collateral leg served as a control and was not trained (NT). Biopsies of the *v. lateralis* were taken at 0, 2 and 4 wk for analysis of Carn and taurine. Study b): a further 7 students of similar age, height and mass undertook a similar study but trained for 1h/d, 5d/wk for 4 wk, undertaking 60 min of self-paced work with one leg (T). The collateral leg again was not trained (NT). Biopsies were taken at 0 and 4wks. 4 subjects were supplemented with β -Ala; 3 with placebo. **RESULTS** Study a): In those subjects supplemented with β -Ala, Carn increased 34.5±13.5% (P<0.05) and 52.2±5E 10.7% (P<0.05) in T at 2 and 4wk, and, 16.7±5E 6.4% (P<0.05) and 28.3±5E 11.2% (P<0.05) in NT. In the absence of β -Ala supplementation there was no change in Carn in either T or NT. Tau did not change in any condition. Study b): The same trend occurred as in study a) with carn increased with β -Ala supplementation. **CONCLUSION** Carn was unchanged by 4wk training alone but was increased when β -Ala supplementation was included. The change in Carn with training + supplementation > than supplementation alone, but was not significant.

INTRODUCTION

Carnosine (β -alanyl-L-histidine) (Carn) occurs in high concentrations (~20 mmol.kg⁻¹ dm) in skeletal muscle, particularly in type II fibres (Harris *et al*, 1998; Hill *et al*, 2006). A pKa of 6.63 allows Carn to function as an effective intramuscular H⁺ buffer (Harris *et al*, 1990). Harris *et al*, (2006) has demonstrated that 4 wk of β -Alanine (β -Ala) supplementation can increase concentrations by ~60% and these increases can significantly improve anaerobic exercise capacity (Hill *et al*, 2006).

Muscle Carn concentrations [Carn] are increased after chronic training (Parkhouse *et al*, 1985; Kim *et al*, 2005; Tallon *et al*, 2005). Tallon *et al*, (2005) reported [Carn] in UK bodybuilders of 43.0 ± 8.3 mmol.kg⁻¹ (dm) whilst Kim *et al*, (2005) showed Korean speed skaters having concentrations of 36.2 ± 9.8 mmol.kg⁻¹ (dm). Parkhouse *et al*, (1985) demonstrated that sprint trained athletes had greater [Carn] than endurance or un-trained subjects. Suzuki *et al*, (2004) reported that 8 wk of sprint training significantly increased [Carn] (5.17±1.69 to 11.01±3.05 mmol.kg⁻¹ wet muscle) and these increases correlated to significant improvements in mean and peak power output during a 30s Wingate test. However Mannion *et al*, (1994) found no effect of isokinetic training on [Carn]. It is therefore unclear as to the effect on Carn synthesis of short duration training, as well as the combination of this with β -Ala supplementation.

AIM: To investigate the combined effect of 4 wk training, and β -Ala supplementation on skeletal muscle [Carn].

MATERIALS AND METHODS

SUBJECTS: 21 Vietnamese PE students.

Study a) n = 14, study b) n = 7

Table 1) Subject characteristics (Mean ± SD)

Group	Age (yrs)	Height (cm)	Mass (kg)
β -alanine	22.0 ± 2.8	171.3 ± 3.6	60.5 ± 3.1
Placebo	21.7 ± 2.6	171.0 ± 8.8	65.3 ± 13.3

Supplementation

β -Ala supplemented groups: n = 7 (study a) and n = 4 (study b) received 800mg x 8/d x 4wk β -Ala (Carnosyn™, NAI, San Marcos, Ca).

Placebo groups: n = 7 (study a) and n = 3 (study b) were given matching doses of maltodextrin.

Training

Study a)

Comprised of 1-leg (leg T) isokinetic exercise 3d/wk during wks 1-2 and 4d/wk during wks 3-4. Each session consisted of 10 x 10 maximal 90° extension and flexion contractions @ 180°/s using a Kin-Kom isokinetic dynamometer, with 1 min rest between bouts. The collateral leg served as a control (leg NT).

Study b)

Comprised of 1 legged cycling (leg T). 5d/wk of 60 min self paced work. Again the collateral leg served as a control (leg NT).

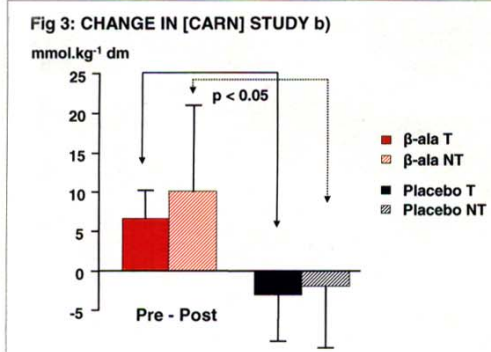
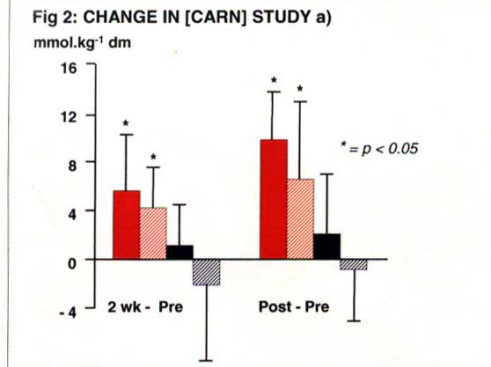
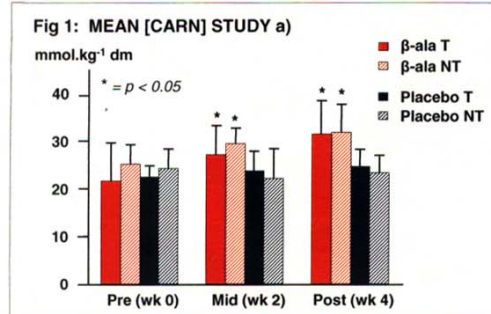
Muscle Biopsies: Per-cutaneous muscle biopsies were taken from the *vastus lateralis* from both legs T and NT. In Study a) biopsies were taken at wks 0, 2 and 4, and in study b) at 0 and 4 wks. Muscle samples were analysed for Carn and taurine (Tau) by HPLC.

RESULTS (mean ± SE)

Biochemistry: Carnosine

Study a) figs 1 & 2: [Carn] in the β -Ala group increased by 6.88±1.38 mmol.kg⁻¹ dm (34.3%) (P<0.05) and 9.63±1.48 mmol.kg⁻¹ dm (52.2%) (P<0.05) in T at wks 2 and 4, and 4.42±1.33 mmol.kg⁻¹ dm (16.7%) (P<0.05) and 6.55±2.36 mmol.kg⁻¹ dm (28.3%) (P<0.05) in NT. [Carn] did not change in either T or NT with placebo.

Study b) fig 3: [Carn] increased by 34.1±8.6% (P<0.05) and 63.52±35.91% (P<0.05) in T and NT in the β -Ala group at wk 4. There was no change in [Carn] in the placebo group.



Biochemistry: Taurine

There was no significant change in skeletal muscle [Tau] in any condition in either study a) or b)

CONCLUSIONS

4 weeks of β -Ala supplementation caused a 52.2% increase in [Carn], similar to that reported previously (Harris *et al*, 2006).

From the Henderson-Hasselbach equation there is a 1:1 relationship between [Carn] and the contribution to buffering capacity (β). Therefore the mean increase in β -Carn as a result of β -Ala supplementation, will also be 52.2%.

Assuming Carn contributes for 12.5% of β_{total} , supplementation, then the increase in β_{total} would be 6.25%. However as total buffering capacity of skeletal muscle is determined by homogenization of muscle followed by titration with HCl, which almost certainly overestimates $\beta_{non-Carn}$, then the effect on β_{total} of β -Ala supplementation will be much greater (we would suggest double).

Data from both studies a) and b) showed that training alone did not result in any significant change in Carn concentrations. This agrees with the results of Mannion *et al*, (1994) but contrasts with data of Suzuki *et al*, (2004).

Although not significant there was a trend in study a) towards a greater increase in [Carn] with training + β -Ala supplementation. This was not apparent in study b), possibly due to the low numbers. This suggests that the greatest increases in [Carn] will be through a combined training/supplementation program of sufficient duration.

Training and/or supplementation did not result in any significant change in [Tau].

In summary muscle [Carn] is not changed by 4 wk of training alone, but data from study a) indicates that training + β -Ala supplementation may have an additive effect on [Carn], and as a result on muscle buffering capacity.

ACKNOWLEDGEMENT

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