Short Paper

Effect of *Garcinia cambogia* extract on body weight gain, feed intake and feed conversion ratio, and serum non-esterified fatty acids and C-reactive protein levels in rats fed with atherogenic diet

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Summary

The aim of the study was to investigate the improving effect of *Garcinia cambogia* extract on performance metrics, and serum non-esterified fatty acids (NEFA) and C-reactive protein (CRP) levels in rats fed with atherogenic diet. Thirty, one-year-old, female Sprague-Dawley rats were randomly assigned to three experimental groups of ten animals each. Control group was fed with basal diet (2% liquid vegetable oil, 0% cholesterol), while the diets of groups 2 and 3 contained vegetable oil (2% liquid- and 5% hydrogenated-vegetable oil) and cholesterol (3%). 4.5% *Garcinia cambogia* was added to the diet of group 3 from day 45. Performance metrics were significantly lower in group 3 than the other groups. Serum NEFA levels were significantly higher in group 3 than the control group on day 45, and in group 3 compared with the other groups on day 75. Serum CRP levels were not significantly different among all groups in all days. In conclusion, the reduced performance metrics indicate that supplementation with *Garcinia cambogia* extract is a novel therapeutic tool for weight management. Also, this study indicates that large doses of *Garcinia cambogia* can lead to a substantial increase in serum NEFA concentrations which may be due to the increased fat degradation.

Key words: Body weight gain, CRP, Feed intake, *Garcinia cambogia*, NEFA

Introduction

Pharmacologic and dietary treatments that might counteract overeating are of increasing interest (Brandt *et al*., 2006). Substances that block fatty acid synthesis may be useful to prevent body weight gain. *Garcinia cambogia* is seen abundantly in the evergreen forests of Konkan in South India (Koshy *et al*., 2001). Hydroxycitrate (HCA) is an active ingredient that is extracted from the rind of the fruit *Garcinia cambogia* (Hill and Peters, 1998), and has been demonstrated to reduce feed intake in animals, suggesting its role in the treatment of obesity (Preuss *et al*., 2004).

The aim of the study was to investigate the improving effect of *Garcinia cambogia* extract on performance metrics, serum non-esterified fatty acids (NEFA), and C-reactive protein (CRP) levels in rats fed with atherogenic diet.

Materials and Methods

This study was approved by the Local Ethical Committee of Istanbul University, Faculty of Veterinary Medicine (approval number: 2006-181). Thirty, one-year-old, female Sprague-Dawley rats with an average weight of 229 g were randomly assigned to three experimental groups of ten animals each.

The rind extract of the fruit *Garcinia*

cambogia was provided by General Nutrition Products, Inc., SC, US. Control group was fed with basal diet (2% liquid vegetable oil, 0% cholesterol), while the diets of groups 2 and 3 contained vegetable oil (2% liquid- and 5% hydrogenated-vegetable oil) and cholesterol (3%). 4.5% *Garcinia cambogia* extract containing 65% HCA was added to the diet of group 3 from day 45. The metabolisable energy (MJ/kg) of diet was 12.5 in the control group and 13.7 in the groups 2 and 3, and the crude protein (%) was 19.5 in all groups.

Feed intake was determined by measuring the amount of the daily consumed and refused feed. Feed conversion ratio (feed intake/body weight gain) was calculated for each group. Blood samples were withdrawn on days 0, 45 and 75. Serum NEFA (Wako Chemicals GmbH, Germany) and CRP (BenSRL, Italy) levels were determined by using the commercially available spectrophotometric kits. Data were compared by using ANOVA between groups within each blood sampling day for blood indices, and between groups throughout the treatment (days 0-75) for performance metrics.

Results

The performance metrics and serum NEFA and CRP levels are indicated in Table 1. All of the performance metrics were significantly lower in group 3 than the other groups. Serum NEFA levels were significantly higher in group 3 than the control group on day 45, and in group 3 compared to the other groups on day 75. Serum CRP levels were not significantly different among all groups on days 0, 45 and 75.

Discussion

Mattes and Bormann (2000) also found a greater food intake reduction using HCA during 12 weeks compared to placebo in humans. The feed intake was significantly lower in group 3 than the control group and group 2 in this study. This is in agreement with Mattes and Bormann (2000). An indirect stimulation of hepatic fatty acid oxidation, due to the reduced formation of the carnitine palmitoyltransferase-I inhibitor malonyl CoA, has been suggested to contribute to the mechanism of the reducing effect of HCA on feed intake (Kovacs *et al*., 2001). Another strategy to achieve long-term reduction in feed intake may be to exploit a possible synergism between postabsorptive, metabolic mechanism of satiety and preabsorptive feedback signals, which are known to play a major role in meal termination (Leonhardt *et al*., 2004b; Dashtizadeh *et al*., 2008).

Ichi *et al*. (2007) reported that no differences were observed in daily feed consumption across three groups (the high-fat group, the control group and the cholesterol group). Similarly, the feed intake was not significantly different between the

Table 1: Serum NEFA and CRP levels and performance metrics in rats fed with the atherogenic diet and *Garcinia cambogia* extract

	Group 1	Group 2	Group 3	P-value
NEFA (mmol/L)				
Day 0	0.381 ± 0.219^{a}	0.275 ± 0.162^{a}	0.333 ± 0.243^{a}	0.467
Day 45	0.486 ± 0.213^{a}	0.686 ± 0.315^{ab}	0.945 ± 0.458^{b}	0.171
Day 75	0.455 ± 0.173^{a}	0.591 ± 0.197^{a}	0.871 ± 0.350^{b}	0.030
CRP (mg/L)				
Day 0	8.68 ± 5.27^{a}	7.44 ± 4.13^{a}	7.86 ± 4.24^{a}	0.284
Day 45	10.60 ± 4.75^{a}	9.06 ± 3.99^{a}	10.10 ± 4.39^{a}	0.808
Day 75	9.70 ± 3.62^{a}	9.23 ± 6.54^{a}	10.80 ± 6.13^{a}	0.235
Body weight gain (g)	5.30 ± 0.14^{a}	5.39 ± 0.29^{a}	4.50 ± 0.21^{b}	0.029
Feed intake (g)	13.54 ± 0.17^{a}	13.57 ± 0.45^{a}	12.47 ± 0.32^{b}	0.006
Feed conversion ratio	0.39 ± 0.01^{a}	0.39 ± 0.02^{a}	0.36 ± 0.02^{b}	0.473

Means in a line that are not followed by a common letter are significantly different ($P<0.05$). Mean ± SD, n=10. P-value of significant difference among three groups by analysis of variance in each line

control group and group 2 in the present study. Hayamizu *et al*. (2003) found that body weight tended to be lower in the *Garcinia cambogia* group than the placebo group at both 12 and 16 weeks. In the present study, body weight gain was significantly lower in group 3 than in group 2. This finding is similar to the findings of Hayamizu *et al*. (2003). According to Brandt *et al*. (2006), the effects of HCA on body weight gain were accounted for entirely by the reduction in feed intake. There was not a significant difference between the control and group 2 for body weight gain in this study. Similarly, Ichi *et al*. (2007) reported that body weights of the high-fat group were higher than the control group, but no difference was observed between control and cholesterol group.

Hayamizu *et al*. (2003) indicated that the feed conversion efficiency of HCA group was significantly lower compared to the control group at the end of the *ad libitum* feeding period. In the present study, the result that HCA decreased the feed conversion efficiency is in line with the previous result (Hayamizu *et al*., 2003). A decreased absorption of energy-yielding substrates due to dietary HCA could also be an explanation for the reduced feed conversion efficiency (Leonhardt *et al*., 2004b).

Leonhardt *et al*. (2004b) reported that plasma NEFA did not differ between HCA and control groups. Serum NEFA concentrations were significantly higher in group 3 than the other groups in this study. This result is not consistent with the result of Leonhardt *et al*. (2004b). Preuss *et al*. (2004) demonstrated that HCA can effectively cause fat degradation and beneficially regulate lipid profiles. In the present study, the reason for the higher serum NEFA concentrations in group 3 may be high visceral fat oxidation due to dietary *Garcinia cambogia* as reported by Preuss *et al*. (2004) because *Garcinia cambogia* containing the high HCA rate (65% in the present study) promotes lipolysis in tissues (Leonhardt *et al*., 2004a). So, serum NEFA levels may increase.

Chess *et al*. (2009) reported that plasma CRP was not different between the two groups fed with low-fat diet (10%) and high-fat diet (45%) for 6 weeks. Asghar *et al.* (2007) found that HCA reduced the levels of inflammation as measured by plasma CRP concentrations. In the present study, serum CRP levels were not significantly different among all groups in days 0, 45 and 75. This is similar to the findings of Chess *et al*. (2009) for high-fat diet, whereas it is not consistent with the findings of Asghar *et al.* (2007) for HCA supplementation. This inconsistency may be due to the different doses of HCA or the different treatment periods in the two studies. Further studies are needed to determine whether chronic consumption of high-fat and/or *Garcinia cambogia* could change the serum CRP levels.

In conclusion, the reduced performance metrics indicate that supplementation with *Garcinia cambogia* extract is a novel therapeutic tool for weight management. Also, this study indicates that large doses of *Garcinia cambogia* can lead to a substantial increase in serum NEFA concentrations which may be due to the increased fat degradation.

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