Original Article

Are energy drinks contributing to the obesity epidemic?

Elaine Rush PhD[1], Stephanie Schulz BAppSc[1], Vladimir Obolonkin PhD[1], David Simmons FRACP, MD[2] and Lindsay Plank Phil[3]

[1] *Division of Sport and Recreation, Faculty of Health and Environmental Sciences, Auckland University of Technology,*
[2] *Waikato Clinical School*
[3] *Department of Surgery, University of Auckland. Auckland, New Zealand*

The consumption of energy drinks containing sucrose and caffeine is increasing worldwide. Ten healthy women aged 18 to 22 years and fasted overnight were randomly allocated to a standardised dose of sucrose either as an "energy " drink (containing sucrose and caffeine) or lemonade on the first day and then crossed over to the alternative drink on a second day. For thirty minutes before and thirty minutes after drinking oxygen consumption and carbon dioxide production were measured in the resting subject breath-by-breath by indirect calorimetry and the rates of carbohydrate and fat oxidation calculated. Energy drink consumption apparently caused increased carbohydrate oxidation (P = 0.004) and reduced lipid oxidation (P = 0.004) compared to lemonade. The longer term effects of combined caffeine and sucrose intake, particularly in sedentary individuals, on metabolism and body fatness needs further examination.

Key Words: lipogenesis, caffeine, sucrose, carbonated beverage, fat oxidation, carbohydrate oxidation.

Introduction

The world is experiencing an epidemic of obesity and Type 2 diabetes. This is thought to be due to significant lifestyle changes over the last 30 years which include an increase in the consumption of drinks containing both sucrose and caffeine.[1] Fructose which is produced along with glucose from the breakdown of sucrose has been implicated in weight gain and the insulin resistance syndrome.[2] Caffeine is recognised as an ergogenic aid[3] and a diet high in simple carbohydrates increases fatty acid synthesis[4] but few studies have examined the effect on substrate metabolism of the ingestion of sucrose with caffeine. Caffeine- and sucrose- containing drinks are marketed as energy boosting and therefore an aid to weight loss. Caffeine alone is unlikely to increase fat oxidation and may increase insulin resistance in skeletal muscle.[3] New Zealand's "V" energy drink (Frucor Beverages, Manukau City, New Zealand) contains 28g sucrose and 81mg caffeine per 250-mL can which is similar to the quantities of sucrose in soft drinks and caffeine in a brewed cup of coffee. We report the results of a study investigating the effects of V on fat and carbohydrate oxidation compared to sucrose alone.

Methods

Ten healthy women, (2 Chinese, 4 Philipino, 1 Indian, 3 European) aged 18 to 22 years (BMI 22.3 (3.5) kg/m^2) and fasted overnight were randomly allocated to a standardised dose of sucrose (0.4g/kg body weight) either as V energy drink (V group) or lemonade (L group) on the first day and then crossed over to the alternative drink on a second day. Both drinks were reported to have equal carbonation (personal communication) and were opened just prior to consumption. The subjects reclined on a bed supported by cushions. For 30 minutes before and 30 minutes after drinking VO_2 and VCO_2 were continuously measured breath by breath (Vista CPX, Vacumed, Ca) and heart rate was measured every minute by pulse oximetry. Respiratory exchange ratio (RER) was calculated as VCO_2/VO_2. From these data carbohydrate and fat oxidation rates were calculated.[5] The study was approved by the Auckland University of Technology Ethics Committee. Standard statistical techniques for crossover studies were used to assess treatment effect, period effect and treatment x period interaction by Student t test.[6]

Results

Complete data were collected from all 10 women. In 10 of 10 women the consumption of V caused a progressive increase in the oxidation of carbohydrate and reduction in the oxidation of fat compared with lemonade. Figure 1 shows the aggregate 30-min cumulative data for all women for carbohydrate and fat oxidation for the two beverages. The increase in carbohydrate oxidation rate following V consumption was greater than that observed following lemonade consumption (P = 0.004, Table 1).

Correspondence address: Prof. Elaine Rush, Auckland University of Technology, Private Bag 92006, Auckland 1020, New Zealand.
Tel: 64 9 917 9999 x 809; Fax 64 9 917 9973
Email: elaine.rush@aut.ac.nz
Accepted 21st July 2005

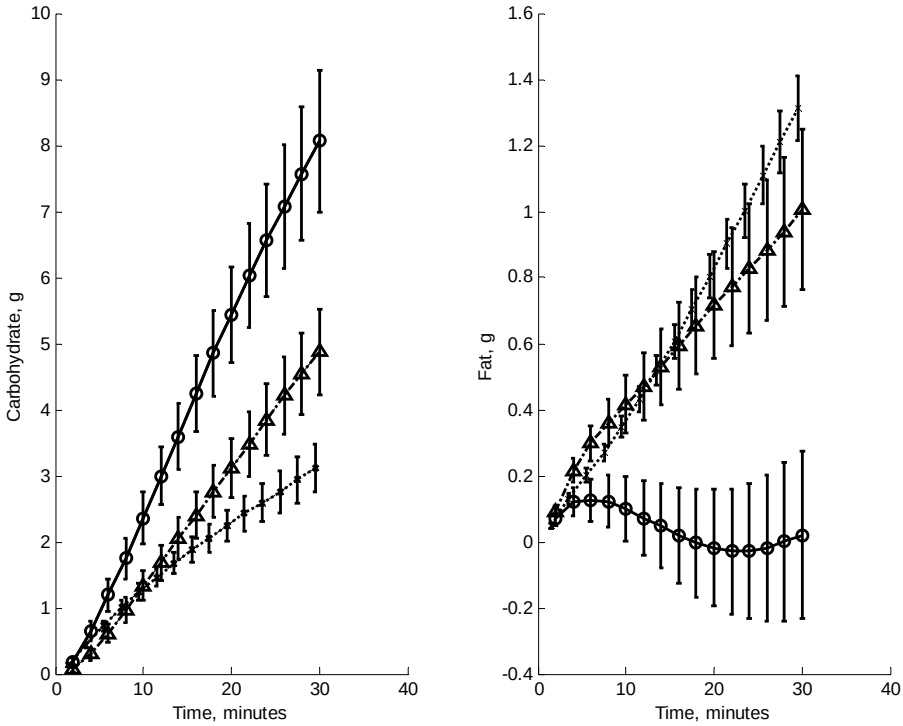

Figure 1. Cumulative carbohydrate and fat oxidation before (x) and after consumption of lemonade (triangles) or V energy drink (circles) in 10 women. Data are mean ± SEM over two minutes of breath by breath recording. Results obtained before lemonade and before V consumption were similar and are combined in the figure.

Table 1. Crossover trial of effects of V energy drink consumption relative to lemonade on respiratory parameters and substrate oxidation in 10 women.

	Treatment			*P* treatment
		Before drink	After drink	-
Heart rate	V	70·8 (2.1)	71.6(2.8)	0·094
(beats/min)	L	69.1(2.2)	71.4(2.8)	
Respiratory	V	16·1(0·8)	16.7(0·8)	0·115
Rate (/min)	L	15.7(1.0)	15·6(1.1)	
VE (L/min)	V	7.2(0·4)	8·9(0·5)	0·014
	L	7·2(0·3)	7.9(0·4)	
VCO_2	V	225(13)	285(17)	0·020
(mL/min)	L	219(7)	252(10)	
VO_2	V	269(12)	304(13)	0·261
(mL/min)	L	266(8)	291(11)	
CHO oxidation (g/min)	V	0·113(0·024)	0·275(0·036)	0·004
	L	0·099(0·013)	0·168(0·022)	
Fat oxidation (g/min)	V	0·044(0·006)	0·001(0·009)	0·004
	L	0·047(0·004)	0·034(0·008)	

Values are mean(SEM) over 30 minutes of recording. No significant period effect or treatment x period interaction were observed so the data before and after each treatment were pooled. Abbreviations: V, V energy drink consumed:, L, lemonade consumed, VE, minute volume; VCO_2, carbon dioxide consumption rate; VO_2, oxygen uptake rate; CHO, carbohydrate.

This was accompanied by decreased fat oxidation rate after both drinks. The rate of fat oxidation after V consumption was negative between the 8 and 22 minute time points (and at this time the RER was greater than 1.00) indicating lipogenesis when compared with lemonade consumption (P = 0.004). V consumption was also associated with a significant increase in minute volume (P = 0.014) and VCO_2 (P = 0.020) but no statistically significant change in heart rate, respiration rate or VO_2.

Discussion

In this small study of young women we have demonstrated that consumption of a standardised amount of an energy drink containing sucrose and caffeine amounting to 24 g of sucrose and 80 mg of caffeine for a 60 kg body weight increases depth of respiration and increases carbohydrate oxidation but suppresses fat oxidation and could cause lipogenesis. We have only considered one variety of energy drink in this study and the caffeine was derived from both added caffeine (200mg/L) and guarana (120 mg/L).

We are not aware of any human studies that have examined the synergistic effects of sucrose and caffeine or guarana on fat metabolism. A study of men[7] using the hyperinsulinemic-euglycaemic clamp technique to examine glucose disposal in resting humans suggested that caffeine acts as an adenosine receptor antagonist and lowers glucose uptake. They showed that glucose uptake was 24% less and glycogen storage 35% less with caffeine compared to a dextrose placebo. They proposed that skeletal muscle became more resistant to insulin with the administration of caffeine. Our dose of caffeine (1.3 mg/kg body weight) was particularly low compared with other studies of ergogenic effects[3] which range from 2-9

mg/kg; however our dose is more reflective of the real-life situation. The wide perception that these drinks are designed as energy boosters needs to be tempered by the fact they may also be lipogenic. This may have implications for consumption of food and drink where caffeine and simple sugars are both present. The reported half-life of caffeine in the body is 4-6 hours.[3] The longer term effect of com-bined caffeine and sucrose intake particularly in sedentary individuals on promotion of lipogenesis and insulin resistance in relation to frequency of consumption, needs urgent examination.

References

1. Bray GA, Nielsen SJ, Popkin BM. Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. Am J Clin Nutr 2004; 79: 537-43.
2. Elliott SS, Keim NL, Stern JS, Teff K, Havel PJ. Fructose, weight gain, and the insulin resistance syndrome. Am J Clin Nutr 2002; 76: 911-22.
3. Graham TE. Caffeine and exercise: metabolism, endurance and performance. Sports Med 2001; 31: 785--807.
4. Hudgins LC, Hellerstein MK, Seidman CE, Neese RA, Tremaroli JD, Hirsch J. Relationship between carbohydrate-induced hypertriglyceridemia and fatty acid syn-thesis in lean and obese subjects. J Lipid Res 2000; 41: 595-604.
5. Frayn KN. Calculation of substrate oxidation rates in vivo from gaseous exchange. J Appl Physiol 1983; 55: 628-634
6. Hills M, Armitage P. The two-period cross-over clinical trial. Br J Clin Pharmacol 1979; 8: 7-20.
7. Greer F, Hudson R, Ross R, Graham T. Caffeine ingestion decreases glucose disposal during a hyperinsulinemic-euglycemic clamp in sedentary humans. Diabetes 2001; 50: 2349-2354.

Original Article

Are energy drinks contributing to the obesity epidemic?

Elaine Rush PhD[1], Stephanie Schulz BAppSc[1], Vladimir Obolonkin PhD[1], David Simmons FRACP, MD[2] and Lindsay Plank Phil[3]

[1] *Division of Sport and Recreation, Faculty of Health and Environmental Sciences, Auckland University of Technology,*
[2] *Waikato Clinical School*
[3] *Department of Surgery, University of Auckland. Auckland, New Zealand*

能量型饮料的消费包含了全球范围内蔗糖和咖啡因的增加。10 名年龄在 18－22 岁之间的健康女性禁食整夜后第一天被随意分配到一标准剂量的蔗糖或者剂量相当的一能量型饮料（含有蔗糖和咖啡因）或者柠檬水，第二天变为二中择一的饮料。在喝之前 30 分钟和喝之后 30 分钟分别测定氧的消费量和二氧化碳的产生量，其余者用间接量热法测定动态补偿和碳水化合物以及脂肪氧化的速度。与柠檬水相比，能量型饮料的消费显然导致碳水化合物的氧化增加及脂质氧化的减少。长期摄入咖啡因和蔗糖组合的人，特别是惯于久坐的人，新陈代谢和体脂肪需要进一步的检查。

关键词：脂肪合成、咖啡因、蔗糖、充碳酸气的饮料、脂肪氧化、碳水化合物氧化。