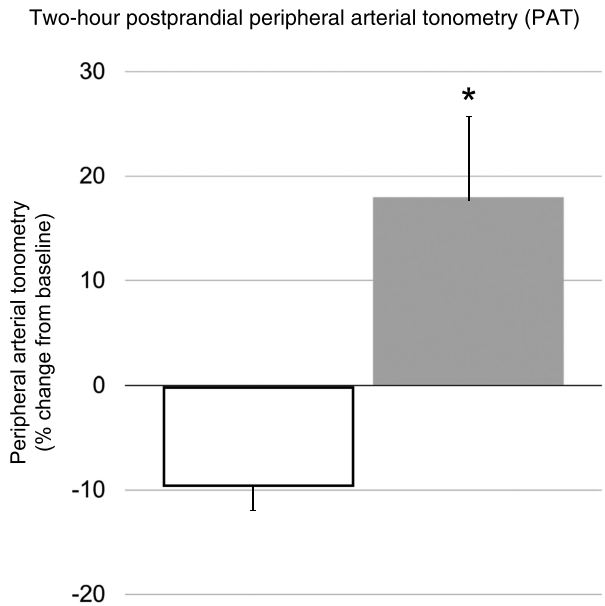

FIGURE. Two-hour postprandial peripheral arterial tonometry (PAT) score change from baseline after eating a burger with salt (□) or an added spice mixture (■).[6] Data are mean ± SD; n = 18. *$P < .05$. Reprinted with permission of John Wiley and Sons from Li Z, Henning SM, Zhang Y, Rahnama N, Zerlin A, Thames G, Tseng CH, Heber D. Decrease of postprandial endothelial dysfunction by spice mix added to high-fat hamburger meat in men with type 2 diabetes mellitus. *Diabetic Med*. 2013;30(5):590–595. © 2013 Li, S. M. Henning, Y. Zhang, N. Rahnama, A. Zerlin, G. Thames, C. H. Tseng, D. Heber. Diabetic Medicine © 2013 Diabetes UK.

postprandial vascular dilation. The effects demonstrated on lipid oxidation in healthy volunteers and on endothelial function in individuals with type 2 diabetes suggest that spice and herb mixtures added to cooked foods may provide potential cardiovascular benefits for people with diabetes.

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Red Pepper Can Enhance Energy Metabolism and Satiety

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RED PEPPER CAN ENHANCE ENERGY METABOLISM AND SATIETY

Capsaicin is the pungent, active ingredient of hot red peppers (*Capsicum frutescens* L., Solanaceae). When placed in the mouth, it binds to receptors on neurons found on the tongue that are sensitive to heat and pain; after binding, neurotransmitters are released, and a sensation of warmth or burning is felt.[1] Because capsaicin has been reported to decrease body fat in rats, there is interest in determining whether it might also help people manage or lose weight. This article describes key studies on the metabolic effects of capsaicin and summarizes the findings of 2 meta-analyses that examined the effects of capsaicin on energy intake and appetite.

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EFFECT OF CAPSAICIN ON ENERGY EXPENDITURE AND FAT OXIDATION

A meta-analysis of 12 clinical studies was undertaken to assess the effects of capsaicin on energy expenditure.[1] The studies were mainly randomized crossover studies in which men and/or women were given 1.03 to 30 g of red pepper (providing 2.25–33 mg of capsaicin) in meals. When analyzed according to dose, capsaicin increased energy

expenditure at high doses (standardized mean difference [SMD], 0.56; 95% confidence interval [CI], 0.06–1.05) but had no effect at low or intermediate doses. Fat oxidation was enhanced at intermediate and high doses of capsaicin (SMD, −0.53 [95% CI, −0.88 to −0.17] and SMD, −0.58 [95% CI, −1.02 to −0.15], respectively), but not at low doses. Thus, capsaicin appears to augment energy expenditure and fat oxidation in humans, but the magnitude of its effects is small (SMD, 0.11 [95% CI, −0.06 to 0.29]).

EFFECT OF CAPSAICIN ON SATIETY AND ENERGY INTAKE

Another way in which capsaicin may affect body weight is through its effects on satiety and energy intake. In 1 study,[2] 24 healthy men and women who were normal weight or slightly overweight and accustomed to eating spicy foods consumed 1 of 4 treatments in random order: 0.9 g of red pepper (0.25% capsaicin, 80 000 Scoville heat units [SHU]) in tomato juice; 0.9 g of red pepper in 2 capsules; a placebo (0.9 g vegetable oil) in tomato juice; or a placebo (450 mg vegetable oil/capsule) in 2 capsules. (The SHU scale measures the pungency or spicy heat of chili peppers or other spicy foods.) The treatments were given 30 minutes before the volunteers ate buffet-style meals over a 2-day period in each of 4 consecutive weeks. Satiety was recorded throughout the test period using visual analog scale (VAS) and calculated using the trapezoidal method to measure the area under the curve (AUC). The AUC for satiety increased, whereas the AUC for hunger decreased, after capsaicin ingestion ($P < .01$) and did not differ between those who were normal weight or overweight. Average daily energy intakes were 10% lower after the red pepper in capsules and 16% lower after the red pepper in tomato juice compared with the placebo groups. A change in food choice explained the reduction in average energy intake: volunteers chose more carbohydrate-rich foods and less fat-rich foods from the buffet during the capsaicin treatments. A surprising finding was that the AUC for satiety increased from 689 to 757 mm·h in men and from 712 to 806 mm·h for women after capsaicin ingestion even as energy intake decreased.

CAPSAICIN, SATIETY, AND ENERGY BALANCE

The literature suggests that capsaicin increases satiety and has the potential to help treat obesity. In 1 study, a respiration chamber was used to measure the effects of capsaicin on appetite and energy intake.[3] (Respiratory chambers are structures in which real-life physiological conditions can be mimicked while a participant eats regular meals and/or exercises during long periods lasting ≥24 hours.) Fifteen volunteers underwent four 36-hour sessions in the chamber, in each instance receiving 1 of the following conditions in a randomized order: 100% of their daily energy intake (control group), 100% of daily energy intake plus capsaicin, 75% of daily energy intake, and 75% of daily energy intake plus capsaicin. Capsaicin was given at a dose of 2.56 mg (1.03 g of red chili pepper; 39 050 SHU) with every meal, giving a daily total capsaicin dose of 7.68 mg. Every waking hour and before and after every meal, the participants rated their satiety and fullness on a 100-mm VAS. These measures were integrated over the complete day, using the trapezoidal method, in order to obtain the AUC of VAS. Measures of satiety and fullness were higher ($P < .05$), whereas food intake and overconsumption tended to be lower ($P < .07$), in the 100% energy capsaicin condition compared with the 100% energy control. When the participants were in negative energy balance (75% of energy intake) and consumed capsaicin, the desire to eat after dinner did not differ from the 100% control. This effect on the desire to eat suggests that capsaicin may counteract the normal increase in appetite that occurs when a reduced-energy diet is followed for weight loss. These findings agree with those of a recent meta-analysis,[4] which reported that consumption of at least 2 mg of capsaicinoids per day reduced energy intake by 74 kcal (310 kJ)/meal ($P < .001$), and suggest that capsaicinoids may serve as a natural weight-loss aid.

CONCLUSIONS

Capsaicin appears to reduce energy intake through sensory, food choice, and satiety mechanisms. Doses of capsaicin between 2.25 and 33 mg in meals have been shown to increase energy expenditure and fat oxidation, which suggests positive benefits for individuals in negative energy balance, as occurs when dieting.

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