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Effect of capsaicin on satiety and diet-induced thermogenesis

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ABSTRACT

Background: One way to reduce net energy intake is by using bioactives, such as capsaicin, which has both satiating effects and can also increase energy expenditure through diet-induced thermogenesis (DIT). In terms of energy stored as body fat, and over a prolonged period, an increase in thermogenesis can have a substantial impact on obesity.

Objectives: To determine the effect of capsaicin on satiety and diet-induced thermogenesis.

Design: Rice and rice plus tabasco sauce was fed to 10 subjects using a two-way cross over design. Height, weight, waist and hip circumference and, body fat content of the subjects were measured together with blood pressure, heart rate, energy expenditure (thermogenesis), and satiety which was measured using visual analogue scale.

Outcomes: Using the area under the curve of thermogenesis versus time, DIT was greater but not significantly so when the subjects consumed rice+Tabasco sauce (treatment containing capsaicin) rather than rice only. Scores for feeling full/not hungry/having less desire to eat 2.5 h after the meal were significantly higher for rice+tabasco sauce than for rice alone. Changes in blood pressure and heart rate were not significantly different in subjects eating the diets.

Conclusion: Capsaicin increased DIT and had a significant satiating effect, but because of inter-subject variability measurement of DIT needs to be more highly powered to reach statistical significance.

INTRODUCTION

Obesity, no matter how it is caused, always involves an imbalance between energy consumed and energy expenditure (EE). Weight loss can be achieved by reducing energy intake and/or increasing EE (Smeets & Westerterp-Plantenga, 2009). There are three main forms of EE: (1) basal metabolic rate (BMR) which is about 65% of daily energy intake (DEI), (2) physical activity (20-30% DEI) and (3) DIT which is about 10% of DEI (Frayn, 2008). Even though, DIT is the smallest component of EE, it could play a role in weight maintenance (Westerterp, 2004).
There is growing evidence that certain bioactive ingredients found in spicy foods or herbal drinks can lead to greater thermogenesis and in some cases to greater satiety (Westerterp-Plantenga et al., 2006). Capsaicin, which gives pungency to hot red peppers (Smeets & Westerterp-Plantenga, 2009), is one such compound that has been reported to increase EE and fat oxidation, and reduce appetite (Kawada et al., 1986; Yoshioka et al., 1998; Kawabata et al., 2006). Increase in activity of the sympathetic nervous system caused by capsaicin seems to be associated with energy and lipid metabolism (Yoshioka et al., 1998; Yoshioka et al., 1999). In the experiment reported here, we present the results of a pilot study in which we tried to replicate previous studies and test experimental protocol prior to more detailed research.

METHODS

Subjects and Experimental Design
Ten volunteers between the age 24 and 60 were recruited. The subjects were fed rice and rice plus Tabasco sauce (source of capsaicin in this study) in a 2-way cross over design. The subjects were asked not to eat anything after 10pm the night before the experiment and were asked to arrive by 8am on the day. After resting for 30min, body measurements including height, weight, waist and hip circumference, body fat content, blood pressure, heart rate were measured. Then they were fed the test meal consisting of either plain boiled white (66g) or the rice plus 3mL of Tabasco sauce estimated to deliver 3mg of capsaicin. DIT was measured using a Fitmate (COSMED Srl, Italy, C02874-02-91) for 30min prior to the meal and for 2.5hr after the meal with 10min breaks every 20min. Satiety profile was measured with the use of anchored 100mm visual analogue scale (VAS). On the test days the questionnaires were completed in fasting state, immediately after the consumption of the test meal and at 2.5h when the experiment stopped. The questions were (1) “How hungry do you feel (0 not hungry at all and 10 being extremely hungry)?”, (2) “How full do you feel (0 being not at all full and 10 being extremely full)?”, (3) “How strong is your desire to eat (0 being not at all strong and 10 being extremely strong)?”, (4) “How much food do you think you can eat (0 being a large amt and 10 being nothing at all)?”. Statistical analysis – the data are presented as mean ± Standard error of the mean (SEM)

RESULTS

Figure 1 shows the changes in metabolic rate over 2.5hr after consuming the test meals. The curves are quite typical of this type of study but because of the large inter individual variation there was no statistically significant difference between the treatments.

VAS rating (Table 1) of hunger, fullness, desire to eat and satiety showed no significant difference between the treatments during fasting and immediately after food consumption. However, 2.5h later a significant decrease in feeling of
hunger and desire to eat was observed in the treatment containing capsaicin, and an increased feeling of fullness and satiety.

No significant differences were observed in the haemodynamic functions.

Table 1: VASmm rating at fasting and 2.5hrs after feeding by the subjects

<table>
<thead>
<tr>
<th>Satiety profile</th>
<th>Rice ± SEM</th>
<th>Rice + Tabasco sauce ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hunger (1):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasting</td>
<td>64.8 ± 6</td>
<td>66.3 ± 8</td>
</tr>
<tr>
<td>Immediately after eating</td>
<td>24.3 ± 4</td>
<td>24.4 ± 5</td>
</tr>
<tr>
<td>2.5 hrs after eating</td>
<td>65 ± 8*</td>
<td>49.1 ± 9*</td>
</tr>
<tr>
<td><strong>Fullness (2):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasting</td>
<td>16.8 ± 4</td>
<td>17.6 ± 3</td>
</tr>
<tr>
<td>Immediately after eating</td>
<td>68.7 ± 3</td>
<td>74.7 ± 6</td>
</tr>
<tr>
<td>2.5 hrs after eating</td>
<td>24 ± 6*</td>
<td>41.8 ± 8*</td>
</tr>
<tr>
<td><strong>Desire to eat (3):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasting</td>
<td>69.8 ± 5</td>
<td>72.2 ± 7</td>
</tr>
<tr>
<td>Immediately after eating</td>
<td>25.7 ± 3</td>
<td>23.7 ± 6</td>
</tr>
<tr>
<td>2.5 hrs after eating</td>
<td>69.2 ± 9*</td>
<td>51.7 ± 9*</td>
</tr>
<tr>
<td><strong>Prospective consumption of food (4):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasting</td>
<td>31.8 ± 6</td>
<td>26.6 ± 6</td>
</tr>
<tr>
<td>Immediately after eating</td>
<td>60.2 ± 8</td>
<td>66.2 ± 9</td>
</tr>
<tr>
<td>2.5 hrs after eating</td>
<td>26.4 ± 8*</td>
<td>45.6 ± 9*</td>
</tr>
</tbody>
</table>

* Significant difference p<0.05

(1), (2), (3), (4) – meaning of terms given in METHODS
DISCUSSION

No significant effect of capsaicin was observed on DIT probably because of the low dosage used (3mg) combined with inter-subject variability. Other studies that used low dosage of capsaicin such as 0.03g, 0.06g have also observed no increase in EE (Snitker et al., 2009; Galgani et al., 2010). The sensitivity of subjects in this study to capsaicin limited the dose that could be given. Another reason for non significant result could be due to the small sample size. Given that intra-individual variability in DIT is 6 to 30% (Segal et al., 1992; Westerterp, 1993) and within-subject variability is 43-48% (Ravussin et al., 1986; Tataranni et al., 1995), a higher powered test with more subjects might be needed to produce significant results. Studies done on Japanese population have shown an increase in EE of up to 30% upon consumption of capsaicin (Yoshioka et al., 1995; Yoshioka et al., 1998). Symapathomimetic compounds like capsaicin could potentially increase thermogenesis by approximately 300-400kJ daily which could lead to substantial weight loss (Hursel & Westerterp-Plantenga, 2010).

From the analysis of VAS, it seems capsaicin caused suppression of hunger, desire to eat less, feeling of fullness and increased satiety which could be
factors in successful weight loss. Exposure to capsaicin increased satiety in other studies as well (Westerterp-Plantenga \textit{et al.}, 2005; Reinbach \textit{et al.}, 2009). Because the capsaicin was able to significantly suppress appetite for 2.5h it may be useful to reduce food intake between meals in weight management.

The fact that measurements of satiety were more significant then the DIT measurements probably reflect the larger number of factors involved in appetite regulation then in DIT.

**CONCLUSIONS**

Capsaicin did not increase DIT but did affect satiety and appetite. Therefore, capsaicin and compounds of similar action may be helpful in reducing energy intake and might support weightloss/maintenance by sustaining satiety and suppressing hunger. However, testing compounds for their effects on DIT requires experimental designs with enough power to overcome inter-individual variability.

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