Effect of Chili Pepper (*Capsicum frutescens*) Ingestion on Plasma Glucose Response and Metabolic Rate in Thai Women

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Abstract

Objectives : To evaluate the effect of 5g fresh chili pepper (CAP) on glucose response after a glucose drink and metabolic rate (MR) in Thai women.

Material and Method : The glucose response after a glucose drink was evaluated in 10 healthy women. The plasma glucose levels at 0, 15, 30 and 60 min after glucose load with and without 5 g fresh CAP were compared. Evaluation of MR was performed in an additional 12 subjects. MR was measured by the ventilated-hood indirect calorimetry system before and for 60 min after CAP ingestion.

Results : The rise of plasma glucose at 30 min after CAP ingestion was significantly lower than the rise of plasma glucose after a plain glucose drink by 20.6 per cent ($p < 0.01$). On the other hand, the CAP ingestion significantly increased MR above resting MR. Moreover, MR immediately increased by 20 per cent within a few minutes after CAP ingestion and showed a remarkable increase of 7.2-17.4 per cent from baseline for 11 min. The significance of thermogenic change was present up to 30 min ($p < 0.05$).

Conclusions : Within 30 min after consumption of 5 g of *Capsicum frutescens,* plasma glucose level during the absorption period was significantly inhibited. The metabolic rate was also immediately increased after ingestion and sustained up to 30 min.

Key word : Chili Pepper, Capsaicin, Glucose, Metabolic Rate

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Chili pepper or *Capsicum frutescens* (CAP) is a common spice used daily in Thai cuisine. Its pungent principle, capsaicin, has many pharmacological actions. Chili pepper and capsaicin were found to affect cardiovascular, gastrointestinal, sensory system and energy metabolism(1-5). In Jamaica, CAP has been used by traditional healers to treat diabetes mellitus(6). Chili pepper and capsaicin were reported to inhibit glucose absorption *in vitro*(7) and also decrease the intestinal glucose absorption in rat(8) and dog models(6). Moreover, the capsaicin intake induces a negative energy balance(5). Accordingly, CAP could have a benefit on human health. This research was undertaken to evaluate the effect of fresh *Capsicum frutescens* consumed in normal amounts by Thais on the glucose absorption and metabolic rate in Thai women.

MATERIAL AND METHOD

This study was reviewed and approved by the Committee on Human Rights Related to Researches Involving Human Subjects, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, based on the Declaration of Helsinki. All subjects gave their written consent after the experimental procedures had been explained to them.

Test materials

Small size, $^3/_4$ inch long, green chili pepper (Prik kee nu) from Bangkok Noi station market were used in the study.

The normal consumption dose of Thai people is 0.1 g chili pepper per kg body weight(9). Therefore, 5 g of fresh chili pepper (*Capsicum frutescens*) containing 3.5 mg of capsaicin (0.07% by fresh weight or 0.34% by dry weight, analysis by HPLC) were employed in the present study.

Subjects

Subjects consisted of healthy Thai women, aged 45-60 years, who did not smoke or were taking any medication or drink alcohol or coffee. They also did not consume chili peppers over 10 g/day. Subjects underwent the recruitment process including dietary assessment, biochemical assessment and history and physical examination.

To evaluate the glucose absorption, 10 subjects were used. The plasma glucose levels after glucose load with and without CAP were compared. Subjects drank 75 g glucose dissolved in 200 ml of water. Blood samples were obtained before and after oral glucose intake at 0, 15, 30 and 60 min. On the following day the same subject underwent the same

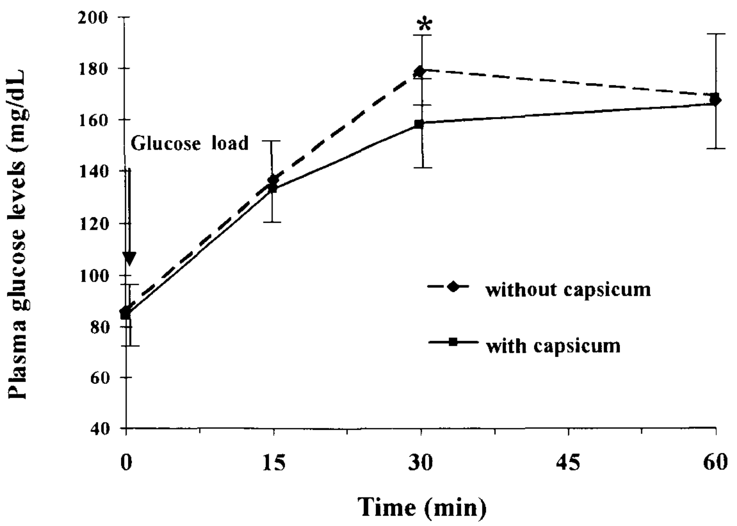

Fig. 1. **Plasma glucose levels with and without capsicum measured over 60 min: Values are means of 10 subjects, with their standard deviation represented by vertical bars. * Significant defference with and without capsicum ingestion, $p < 0.01$.**

experiment but the glucose drink also contained 5 g ground fresh CAP. The plasma glucose was determined by using the enzymatic method described by Barham and Trinder[10].

To evaluate the metabolic rate (MR), 12 subjects were used. Strenuous physical activity was not allowed for 2 days before the experiment. The subjects came to the laboratory early in the morning after an overnight fast. After lying quietly for 30 min, their resting metabolic rate (RMR) was determined for 30 min with the ventilated- hood indirect calorimetry system (Deltatrac metabolic monitor, Datex Instrumentarium, Helsinki, Finland). Subjects then consumed the test drink within 3 minutes. After ingestion, the MR was measured every minute for 60 minutes.

Statistical analysis was performed by using the SPSS for Windows version 11.0. Because the data are not normally distributed, Wilcoxon Signed Ranks Test was used to assess the difference before and after CAP consumption in the same person[11]. Significance was considered at p-value < 0.05.

RESULTS

Glucose response after a glucose drink

After an oral glucose load, the plasma glucose level rose above the baseline by 58.8 per cent at 15 min, and reached its peak (107.6%) at 30 min and decreased at 60 min as shown in Fig. 1. The plasma glucose levels after drinking glucose with CAP rose above the baseline by 57.8 per cent, 87 per cent and 98.9 per cent at 15,30 and 60 min, respectively. The rise of plasma glucose at 30 min after CAP ingestion was significantly lower than the rise of plasma glucose after a plain glucose drink by 20.6 per cent ($p < 0.01$). Nevertheless, plasma glucose with CAP intake reached its peak at 60 min. Plasma glucose increment from baseline at 30 min with CAP intake was significantly lower ($p < 0.05$) than that without CAP by 19 per cent (Fig. 2).

Metabolic rate

The average MR after 5 g CAP intake was significantly higher than RMR before CAP intake (0.94 ± 0.11 kcal/min *vs* 0.89 ± 0.12 kcal/min, $p < 0.01$) as in Fig. 3. The CAP ingestion significantly increased MR by 12.1 per cent, 4.7 per cent and 5.2 per cent at 5 min ($p < 0.005$), 15 min ($p < 0.05$) and 30 min ($p < 0.05$), respectively, compared with RMR before CAP ingestion (Fig. 4). MR increased from baseline by 20 per cent within a few minutes after CAP ingestion and remained remarkably increased by 7.2-17.4 per cent from baseline until 11 min (Fig. 5).

DISCUSSION

Glucose absorption and tolerance

Disturbance of glucose absorption by CAP has been shown in animals[6,8,12]. The present study revealed that CAP also reduced glucose excursion at 30

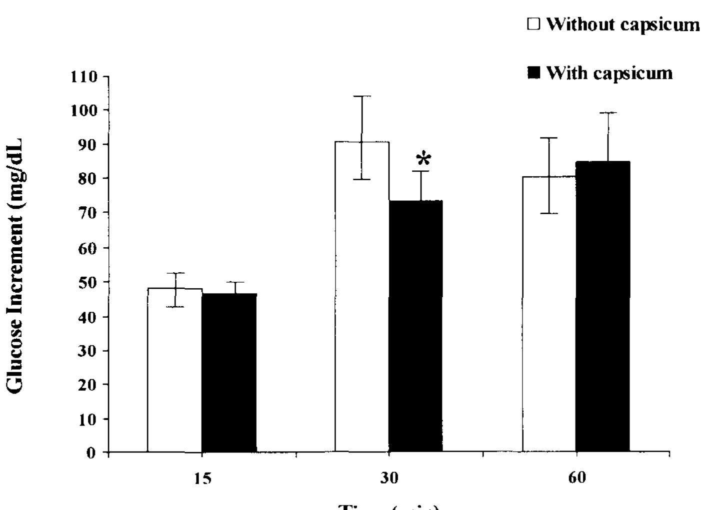

Fig. 2. The glucose increment with and without capsicum ingestion. Values are means with the standard error of mean represented by vertical bars. * Significant difference with and without capsicum, p < 0.03.

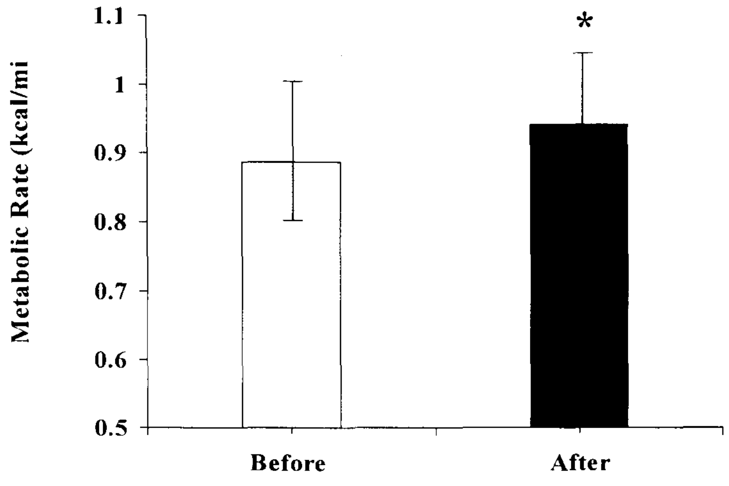

Fig. 3. **Metabolic rate before and after capsicum ingestion. Values are means of 12 subjects, with their standard deviation. * Significant difference at p < 0.01.**

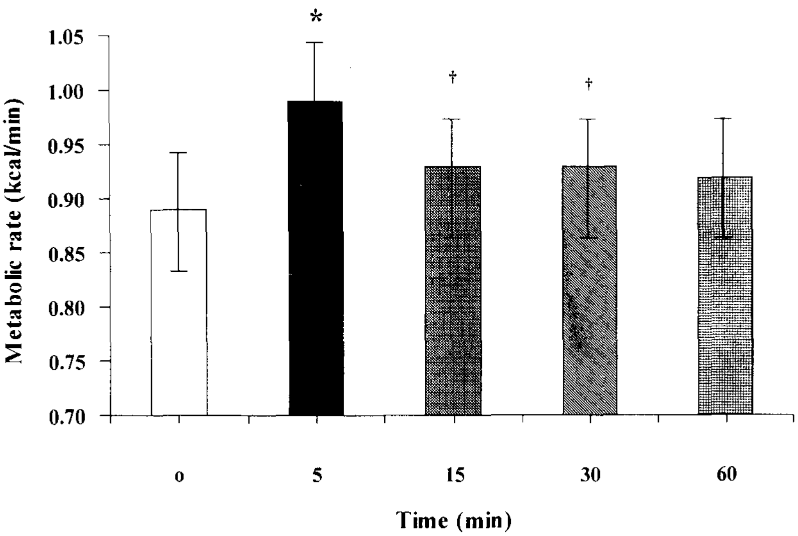

Fig. 4. **Integrated metabolic rate at baseline and 5, 15, 30 and 60 min after capsicum ingestion. Value are mean of 12 subjects, with their standard deviation represented by vertical bars. Significant difference before and after capsicum ingestion, * p < 0.005, † p < 0.05.**

min after ingestion in human (Fig. 1, 2). This might be due to the rapid absorption of CAP from the stomach. Capsaicin was absorbed up to 45.8 per cent in the ligated stomach of rats and 91.4 per cent in jejunum and disappeared from the gastrointestional tract within 1 h after oral administration(13). In addition, the average maximum glucose levels without and with CAP were 174.4 ± 27.3 and 169.2 ± 28.8 mg/dl and the average glucose peak time were at 40 ± 15 min and 46 ± 18 min, respectively. The present study showed that CAP inhibits and retards the glucose absorption process within 30 min of ingestion which concurs with

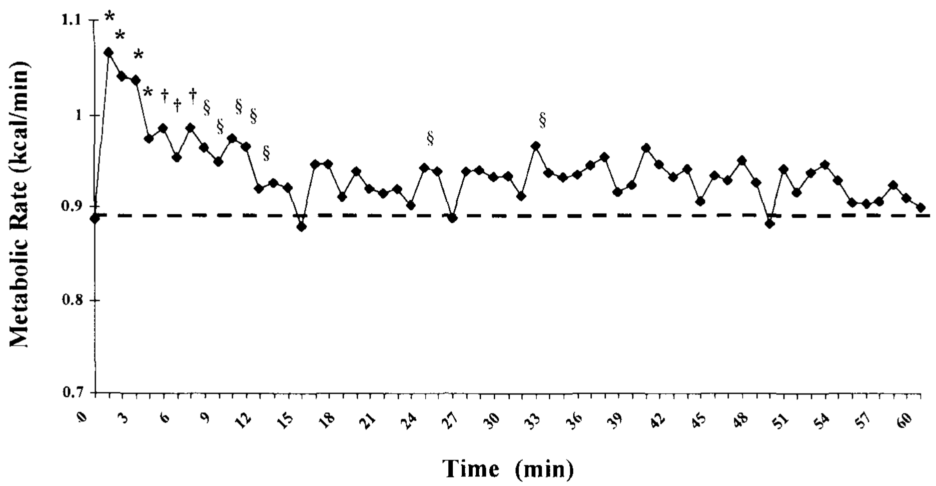

Fig. 5. Metabolic rate before (0 min) and after capsicum intake for 60 min. Significant difference before and after capsicum ingestion, * $p < 0.005$, † $p < 0.01$, § $p < 0.05$.

an *in vivo* study that capsaicin decreased the intestinal glucose absorption after ingestion in rats(8) and dogs (6). This is due to the depression of intestinal glucose transport(7) as well as its effect on increased GI motility(8). Since the insulin activity was not determined in the present study, the authors cannot explain the effect of CAP on insulin activity. However, it was shown that capsaicin stimulated insulin secretion in dogs(6) as well as improved the insulin sensitivity in normal and streptozotocin-induced diabetic rats(12, 14). In addition, it was suggested that sensory nerves were implicated in the control of glucose tolerance through a mechanism independent of insulin release (15). Another explanation may have accounted for the modification of the adrenocorticotropin-corticosteroid axis by capsaicin during cold or restraint stress, capsaicin markedly reduced ACTH and corticorsterone release(16,17). However, this information is only tentative and further human studies should be performed.

Metabolic rate

Capsaicin intake has been found to induce negative energy balance after only one week of treatment in rats(18). Although it was shown that energy expenditure was increased during the initial 30 min after consumption of breakfast (650 kcal) with 10 g red pepper in Japanese subjects(5,19), the present results showed an immediate response of MR after CAP ingestion. Within a few minutes, MR increased from baseline by 20 per cent and was remarkably increased by 7.2-17.4 per cent from baseline until 11 min (Fig. 5). This response remained significant up to 30 min (Fig. 4). The average maximum MR after CAP ingestion was 1.14 ± 0.13 kcal/min while maximum MR after CAP ingestion of each subject ranged from 0.92-1.31 kcal/min. Interestingly, there were 5 subjects who reached maximum MR within 1 min. However, almost all subjects reached their peak MR within 5 min. Capsaicin influences thermoregulation by affecting hypothalamic warm-receptors(20) *via* its receptors on the sensory neurons in the dorsal root, trigeminal and nodose ganglia(21,22). In addition, the immediate response of MR in the present study may be caused by catecholamine secretion from adrenal medulla through activation of CNS that increased immediately after capsaicin administration(23-25). Furthermore, these adrenergic secretagogues were readily transported *via* the gut into the body(26) and increased plasma norepinephrine and epinephrine levels within 30 min after a meal(27), which explains why we feel hot and sweat while enjoying the delicacy of a meal flavored with *Capsicum frutescens*.

In conclusion, the present results demonstrated that 5 g of *Capsicum frutescens* consumption significantly reduced the plasma glucose level during the absorption period in Thai women. It also increased the metabolic rate immediately after ingestion and sustained it up to 30 min.

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ผลของการบริโภคพริกขี้หนูต่อการเปลี่ยนแปลงของระดับน้ำตาลกลูโคสในพลาสมา และอัตราการเผาผลาญในร่างกายของหญิงไทย

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วัตถุประสงค์ : เพื่อศึกษาการเปลี่ยนแปลงของระดับน้ำตาลกลูโคสในพลาสมา และอัตราการเผาผลาญในร่างกายของหญิงไทย หลังจากบริโภคพริกขี้หนูสดในปริมาณที่คนไทยบริโภคเป็นประจำ

วิธีการ : ในการศึกษาการเปลี่ยนแปลงน้ำตาล ใช้กลุ่มตัวอย่างหญิงไทย 10 คน โดยเปรียบเทียบน้ำตาลในพลาสมา ณ เวลา 0, 15, 30 และ 60 นาที หลังดื่มน้ำกลูโคส 75 กรัมที่มีและไม่มีพริกขี้หนูสดสับละเอียด 5 กรัมผสมอยู่ ส่วนการศึกษาอัตราการเผาผลาญในร่างกายได้ใช้กลุ่มตัวอย่างอีก 12 คน โดยวัดอัตราการเผาผลาญในร่างกาย (metabolic rate) ด้วยวิธี Indirect calorimetry ก่อนและจนกระทั่ง 60 นาที หลังจากบริโภคน้ำ 200 มล ที่มีพริกขี้หนูสดสับละเอียด 5 กรัมผสมอยู่

ผลการศึกษา : น้ำตาลในพลาสมา หลังดื่มน้ำกลูโคสผสมพริก 30 นาที ต่ำกว่าน้ำตาลในพลาสมา หลังดื่มน้ำกลูโคสที่ไม่มีพริก อย่างมีนัยสำคัญทางสถิติถึงร้อยละ 20.6 ในอีกด้านหนึ่งการบริโภคพริกทำให้อัตราการเผาผลาญในร่างกายสูงขึ้น ซึ่งมีการเพิ่มขึ้นถึงร้อยละ 20 ทันทีภายใน 2-3 นาทีหลังบริโภคพริก โดยการเผาผลาญเพิ่มขึ้นอย่างเด่นชัดร้อยละ 7.2-17.4 อยู่นานถึง 11 นาที และการเปลี่ยนแปลงอย่างมีนัยสำคัญนี้ สามารถตรวจพบได้ถึง 30 นาที

สรุป : พริกขี้หนูในปริมาณปกติที่คนไทยบริโภคเป็นประจำทุกวัน (5 กรัม) สามารถลดน้ำตาลกลูโคสในพลาสมาภายในเวลา 30 นาทีหลังบริโภค นอกจากนี้ยังเพิ่มอัตราการเผาผลาญในร่างกายหลังจากบริโภคพริกทันทีและมีผลอยู่นานอย่างมีนัยสำคัญถึง 30 นาทีต่อมา

คำสำคัญ : พริกขี้หนู, แคปไซซิน, น้ำตาลกลูโคส, อัตราการเผาผลาญในร่างกาย

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