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Effects of cinnamon and ginger on supraclavicular skin temperature and health parameters in young men

Esmeralda García-Torres[1*], Verónica Reyes-Meza[2], Guillermo Alejandro Pérez-Flores[3].

[1]Facultad de Odontología, Universidad Autónoma de Tlaxcala, [2]Centro Tlaxcala de Biología de la Conducta, [3]Facultad de Agrobiología. Universidad Autónoma de Tlaxcala, Tlaxcala, México.

RESUMEN

Efecto de la canela y jengibre en la temperatura superficial supraclavicular y parámetros de salud en jóvenes

Introducción. El tejido adiposo pardo en humanos se localiza en diferentes áreas del cuerpo, principalmente en el área supraclavicular y su activación con diferentes moléculas termogénicas podría reflejarse en este sitio. El tejido adiposo pardo activo podría ser una estrategia contra la obesidad considerando su participación en el balance energético.

Objetivo. Evaluar el efecto de la canela y el jengibre sobre la temperatura cutánea supraclavicular y en parámetros de salud en jóvenes.

Material y métodos. Se llevó a cabo un estudio experimental con 36 adultos jóvenes que fueron asignados a uno de los tres grupos de tratamiento: bebida de jengibre, bebida de canela y agua potable como grupo placebo. La temperatura supraclavicular de la piel, la presión arterial, la frecuencia cardíaca, el nivel de glucosa y los triglicéridos se registraron antes y después de ingerir la bebida.

Resultados. Se observó un aumento en la temperatura supraclavicular de la piel después de la ingesta de las bebidas de canela (0.62 °C), jengibre (0.54 °C) y placebo (0.64 °C). En el grupo que ingirió jengibre, también se observó una disminución de la glucosa (6.3 %), un aumento de los triglicéridos (34.4 %) y una disminución en el ritmo cardiaco (13.3 %), pero estas diferencias no fueron significativas en el grupo que ingirió canela ni en el grupo placebo.

Conclusión. Nuestros resultados sugieren que la canela y el jengibre tienen efectos termogénicos en el área supraclavicular en hombres jóvenes.

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*Autor para correspondencia:
Dra. Esmeralda García-Torres,
Facultad de Odontología, Universidad Autónoma de Tlaxcala. Av. Ribereña S/N, Centro, C.P. 90000, Tlaxcala, Tlaxcala, México.
E-mail: 20052829@uatx.mx
https://revistabiomedica.mx.

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ABSTRACT

Introduction. Brown adipose tissue in humans is located in different areas of the body, mainly in the supraclavicular area and its activation with different thermogenic molecules could be reflected in this site. Active brown adipose tissue could be a strategy against obesity considering its participation in energy balance.

Objective. To evaluate the effect of cinnamon and ginger on supraclavicular skin temperature and health parameters in young men.

Material and methods. An experimental study was carried out among 36 young men who were assigned to one of three treatment groups: ginger drink, cinnamon drink, and potable water as a placebo group. The supraclavicular skin temperature, blood pressure, heart rate, glucose level, and triglycerides were recorded before and after ingesting the drink.

Results. An increase in supraclavicular skin temperature was observed after the ingestion of the cinnamon (0.62 °C), ginger (0.54 °C), and placebo (0.64 °C) drinks. In the group that ingested ginger, there was also a decrease in glucose (6.3 %), an increase in triglycerides (34.4 %), and a decrease in heart rate (13.3 %), but not significant in the cinnamon group or the placebo group.

Conclusion. Our results suggest that cinnamon and ginger both have thermogenic effects on the supraclavicular area in young men adults.

INTRODUCTION

Obesity is the product of an interaction between genetic susceptibility and environment, which is expressed when the subject is exposed to a certain set of environmental conditions (1). Some studies have suggested that brown adipose tissue (BAT) has been of great interest for its therapeutic potential in the treatment of obesity because has the ability to dissipate energy in the form of heat by oxidation of glucose and lipids and it facilitates weight loss (2,3). A goal in this field is to determine alternatives for activation of brown/beige fat thermogenesis can prevent body weight gain and reverse metabolic abnormalities in adult humans (4). Several factors have been implicated in BAT activation in humans, such as aging, sex, genetics, cold exposure, adrenergic stimulation (5), exercise, and the consumption of drugs or other substances (3, 6). It has been reported that certain spices can be used as functional thermogenic agents that participate in the energy balance preventing positive energy balance, diabetes, and obesity (7). The most frequently used are caffeine, green tea extract (8), grains of paradise (9), ginger and cinnamon (10, 11).

There are numerous food ingredients activating the TRP-BAT axis that would be useful for obesity management, particularly in spicy foods, having an agonistic activity to TRPV1 (9). For example, ginger, the rhizome of the perennial plant Zingiber officinale, contains the gingerols 6-gingerol, 8-gingerol and zingerone, which are all relatively potent agonists of the transient receptor potential (TRP) TRPV1. TRP proteins are temperature sensors required for thermoregulation that activate the sympathetic nervous system, releasing norepinephrine (12) which might be expected to activate BAT thermogenesis and reduce body fat (9).

However, despite their potential benefits, there is little existing research on thermogenic ingredients effect on human BAT. The ingestion of ginger had the thermic effect of food, with an increase of 42.7 kcal/d (13) and an increase in peripheral and body surface temperature (14). It also enhanced sensitivity to insulin (15), and decreased body mass index (BMI), glucose, leptin and insulin levels, and the degree of hepatic steatosis (16).

Another common thermogenic ingredient is cinnamon, which is obtained from the inner bark of trees of the genus Cinnamomum. Studies in mice and rats have demonstrated that cinnamon extract affects transcription factor activation (PPARγ, PPARα) and regulates gene expression, resulting in improved insulin resistance and reduced blood glucose and serum lipid levels (17, 18). It also increased glucose uptake in adipocytes (19), and had a browning effect on subcutaneous adipocytes (20). In humans, cinnamon has been shown to improve serum glycemic indices and lipid profile of women (21) improve insulin sensitivity (22, 23), reduce cholesterol, triglycerides, low-density lipoprotein,

systolic blood pressure, and body fat percentage, and increase high-density lipoprotein and lean body mass (18, 24, 25).

Considering the demonstrated thermic effects of ginger and cinnamon is possible that these spices participate in BAT activation in humans, which has not been studied. The effect of thermogenic ingredients on BAT could be of great importance to establish possible non-toxic alternatives to treating overweight and obesity. In this work, we evaluated the effect of ingestion of these two thermogenic ingredients on supraclavicular skin temperature (SCST) in healthy young men as an indirect indicator of BAT activity.

MATERIAL AND METHODS

The present research is an experimental study that was carried out among young men from Mexico. The sample included 36 male individuals, randomly divided into three treatment groups (12 individuals per group). One group received ginger (ginger group; GG), one received cinnamon (cinnamon group; CG) and 12 received a placebo (placebo group, PG).

All study participants were male volunteer participants between the ages of 19 and 25 years old with no chronic illnesses. They were requested to fast and abstain from consuming alcohol, caffeine, tobacco, and medications for 12 hours prior to their participation in the study.

Procedure.

At 08:00 h, the study participants arrived to the institutional office and they signed an informed consent to start the experimental procedure. We recorded their heart rate and blood pressure using a Citizen Digital Blood Pressure Monitor Model CH605 (Citizen Systems Japan CO., LTD., Sozhou City 215129, China). For each individual, we calculated the body mass index (BMI; kg/m^2), visceral fat, and body fat percentage. These measurements were obtained with a *Full Body Sensor Monitor* of body composition with an Omron scale, model HBF-514 (OMRON HEALTHCARE, INC., Illinois, USA). A capillary blood sample was obtained to measure glucose by puncturing the left ring finger with an On Call® Plus glucose meter (ACON Laboratories, Inc., San Diego, CA 92121, USA) and triglycerides with a Mission® cholesterol meter (ACON Laboratories, Inc., San Diego, CA 92121, USA). Subsequently, a non-invasive technique (2), an infrared thermography was taken before intake of the thermogenic beverage. Participants attended wearing a white standard cotton T-shirt in order to expose the neck and supraclavicular region, where temperature was measured as an indicator of BAT activation (2). Images were obtained with a thermal imager (FLUKE Ti25 IR Fusion Technology, Everett, WA, USA). Thermographies were recorded one meter away from the individual, with an emissivity of 0.95. The temperature of the room was 22°C ± 1°C.

At 8:30 h, the participants drank 150 ml of the thermogenic beverage corresponding to their treatment group. For the thermogenic beverages, 10 g of fresh ginger root (*Zingiber officinale*) or 10 g of dried cinnamon bark (*Cinnamomum zeylanicum*) were weighed and placed in 200 ml of water at 100°C for two minutes. Subsequently, the infusion was cooled to room temperature, filtered, and the beverages were served as hot drinks at 40°C (26). For the placebo group, individuals drank hot water at 40°C. Both spices were purchased from the local market (26).

Between 9:30 h and 10:30 h, we obtained a thermograph from each participant after they consumed the beverage.

At 11:30 h, we obtained a third thermograph and a second capillary blood sample to measure glucose and triglycerides. The participants remained at rest between the corresponding measurements.

Thermography analysis.

The thermographs were analyzed using the Smart View Software program 4.3. Only the highest SCST value recorded from each individual thermograph was used for subsequent analysis.

Data analysis

Age, BMI, percent body fat, and visceral fat were compared among the treatment groups using an analysis of variance (ANOVA). Cardiac

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pulse, systolic blood pressure, diastolic blood pressure, glucose concentration, and triglyceride concentration before and after ingesting the beverage were compared using paired *t*-tests or Wilcoxon tests within each treatment group, depending on the distribution of the data. SCST was compared among the three times it was taken and among treatments using a repeated measures ANOVA and poshoc Bonferroni multicomparison test. The results are reported as averages ± standard error. The statistical analyses were carried out in SAS version 9.3, considering a significance level of $p \leq 0.05$.

Bioethical considerations.

Individuals agreed to participate in the research project with prior informed consent. This study was done in accordance with the Helsinki Declaration of Human Studies and was approved by the Ethical Committee of Health Office of Mexico (DCES-OI-06/18).

RESULTS

There were no differences among the three treatment groups in terms of age, BMI, percent body fat, or visceral fat. When comparing measures before versus after beverage consumption, no difference was observed between experimental groups in individuals' systolic or diastolic blood pressure.

There was a significant (*W*=-50, *P*=0.05) increase in triglyceride concentration in the GG (**Figure 1**; 136.3±35.85 mg/dl before, 183±36.49 mg/dl after). There was no difference in triglyceride concentration before and after the CG (138.1±28.77and 136.4±19.40 mg/dl, respectively) or the PG consumption (146.9±32.19 and 172.1±27.07 mg/dl, respectively).

For glucose concentration (Figure 1), a significant decrease (*t*-test=2.71, *P*=0.020) was detected after the GG beverage consumption (91.17±1.70 vs. 85.42±1.44 mg/dl, before vs. after, respectively). There was no statistical change in glucose concentration after beverage consumption of CG (87.98±2.71 and 90.0±1.74 mg/dl, before and after respectively) or PG (86.08±2.20 and 87.25±2.08 mg/dl, before and after respectively).

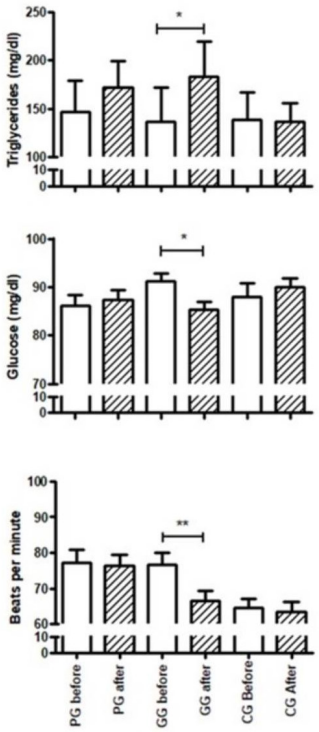

Figure 1. Comparison of triglycerides, glucose and heart rate (beats per minute) before and after intake of the thermogenic (GG, CG) or placebo (PG) beverage. **p* <0.05, ***p* <0.01

There was a significant decrease (*t*-test, *t*=4.39, *P*=0.001) in heart rate (**Figure 1**) after consumption of the GG (mean ± SD of heart rate = 76.75±3.38 vs. 66.50±2.77 bpm before vs. after GG consumption, respectively). This difference was not significant in the CG group (64.50±2.70 vs. 63.50±2.67 bpm before vs. after consumption, respectively) or the PG (77.33±3.43 vs. 76.25±3.18 bpm before vs. after consumption, respectively).

For SCST (**Figure 2**), in the placebo group there was a 0.64 °C increase between before and three hours after beverage ingestion; this difference was significant (*P*<0.01). In the ginger group, there was also a significant increase between SCST before ingestion and one hour after (0.54 °C, *P*<0.05), and two hours after ingestion (0.53 °C, *P*<0.05). In the cinnamon group, there was a significant increase in SCST two hours after ingestion (0.62 °C, *P*<0.01).

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Figure 2. Comparison of supraclavicular skin temperature before, 1h, 2h and 3h after intake of the thermogenic (GG, CG) or placebo (PG) beverage. *p <0.05, **p <0.01

DISCUSSION

The results of this study show an increase in SCST after intake of cinnamon and ginger drinks. That is, these ingredients activate the heat production mechanism in the supraclavicular area, a site that corresponds to a robust BAT deposition in humans (27).

The production of heat in BAT, considered in this study indirectly by the increase in SCST after ingestion of the infusions, occurred through the activation of TRP-type thermoreceptors. These receptors are expressed in sensory nerves and increase the activity of the SNS that innervates BAT. Sympathetic nerve terminals release norepinephrine, which interacts directly with β-adrenergic membrane receptors in brown adipocytes. This interaction activates protein kinase A to promote TGL lipolysis and activate the uncoupling protein UCP-1, thus generating an increase in body temperature (28). This mechanism has been reported in other molecules such as capsaicin and menthol (28,29).

Cinnamaldehyde, a component of cinnamon, is an agonist of transient receptor potential-ankyrin receptor 1 (TRPA1), which participates in sensory processes such as cold. When activated, TRPA1 increases energy expenditure by secreting adrenaline and increasing UCP1 in the BAT (30). This could increase the energy expenditure and stimulation of the BAT (31) explaining the significant increase in SCST we observed after the intake of the cinnamon infusion.

Ginger, gingerols and shogaols have been previously shown to activate the transient receptor potential vanilloid subtype 1 (TRPV1) (32) involved in thermoregulation. In previous studies, the use of 1 g of ginger did not induce changes in the rectal temperature 2 h after its intake (33), but the intake of 280 ml of 0.07 % ginger extract (34) did generate a hyperthermic effect in the palm of the hand 20, 30, 40, 50 and 60 min after consuming a ginger drink. The thermogenic effect of ginger may thus depend on the concentration used. The dose we used was higher than those previously reported, probably leading to the significant increase in the SCST after the infusion in contrast to other studies (33). In PG the precise reason for the increase in SCST after placebo ingestion is unclear. Other studies have previously reported a favorable response with placebo, for example, an increase in resting energy expenditure and weight loss (1,8).

In addition, the GG showed a significant decrease in glucose concentration as well as in heart rate and an increase in triglyceride concentration after ginger ingestion. In previous studies, it has been reported that BAT activation increases energy expenditure and modulates circulating TGL and glucose levels (35-37). Bartlet and collaborators mention that BAT has the ability to eliminate circulating glucose by increasing its recapture and using it as energy fuel in the mitochondria during thermogenesis. Likewise, the mobilization of circulating TGL occurs by increasing its recapture in the BAT (35) as observed after exposure to cold. Then, ginger acts in a similar way to the cold stimulus by activating TRPV1 receptors and triggering the thermogenic mechanism (35,36). This explains the results observed after ginger ingestion. Furthermore, our findings correspond to another study in which an effect of ginger on lipids was also observed after 120 min with a single intake of 1 g of ginger (33).

Regarding the glucose and triglyceride concentration, no significant changes were observed after the intake of cinnamon. In previous studies, it has been reported that cinnamon reduces the

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glucose level in men and women in both prediabetic and diabetic subjects (24, 25, 38) and has also been shown to decrease triglyceride and cholesterol concentrations (24). Although an effect on glucose concentration was not observed in this study for CG, it may be that treatment is required to be administered for a longer period of time to detect a significant decrease, as was done in the studies mentioned above (24, 25, 38). This should occur as a consequence of increased glucose recapture in the BAT by increasing its energy demand during thermogenesis as a result of lipid combustion (39).

This research opens the way to new studies to elucidate the direct participation of the bioactive components of potential thermogenic ingredients, as well as studies on the effects of more prolonged periods of the intake of these spices on brown adipocytes to evaluate its possible influence on the browning mechanism of white adipose tissue and BAT mass increase. It would also be relevant to determine its effect in relation to gender, age and body composition.

CONCLUSION

In this research we demonstrate the thermogenic effect of ginger and cinnamon on the supraclavicular surface and glucose and triglycerides concentration in young men. Therefore, it is suggested that these spices could act as therapeutic agents to reduce high concentrations of triglycerides and glucose, and combat metabolic diseases in humans such as overweight and obesity.

INTEREST CONFLICT

The authors of this research declare no conflict of interest.

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