

Current Understanding of Antiobesity Property of Capsaicin

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ABSTRACT

The capsaicin is an ingredient that we normally mix in food in many cultural cuisines even in fresh and dried production. Because of its anticancer, anticholesterolemic, antidiabetic, antihypertensive, anti-inflammatory, antimicrobial, and antioxidant properties, capsaicin is used worldwide. Moreover, capsaicin is also used for the protection of cardiovascular and hepatic diseases. The electronic databases PubMed, Scopus, Web of Science, Google Scholar, and ScienceDirect were searched since 2000 to present for antiobesity term. This review article is provided the update information about the antiobesity property and mechanism of capsaicin for further researches.

Key words: Capsaicin, chili, obesity, overweight, pepper

TREND OF OVERWEIGHT

The trend of overweight and obesity is increasing and concerning of global health problems. There are many reports in many countries about the increasing rates of these problems. For the example, the 35% of 6445 adults in the age group of 18–70-year-old who were surveyed during 2004–2005 from Thailand had the body mass index (BMI) more than 23 kg/m².^[1] The 15% of 346 adolescents in the age group of 15–18-year-old who were surveyed from Indonesia had the BMI in overweight and obese levels.^[2] In additional, the 37% of 1434 adults in the age group of 20–39-year-old who were surveyed in 2009 from Lebanon had the BMI in overweight level.^[3] Therapeutic strategies for obesity include pharmacotherapy and surgery with the high costs and medical complications.^[4,5] The use of traditional medicinal plant for treating obesity is an alternative approach. It can induce weight loss through several mechanisms such as (1) suppressing appetite and inducing satiety,^[6-8] (2) enhancing lipid metabolism,^[9,10] (3) enhancing thermogenesis,^[11,12] (4) inhibiting pancreatic lipase,^[13-16] (5) inhibiting α -amylase activity,^[17-19] and (6) preventing adipocyte differentiation.^[20,21] In this review, we addressed the most recent studies about the antiobesity property of capsaicin and its possible mechanisms of action is also discussed.

CAPSAICIN

Capsaicin (C₁₈H₂₇NO₃, molecular weight 305.418 g/mol) is an alkaloid compound found in pepper, which the plant is belonging to the genus *Capsicum*.^[22] It is responsible for its characteristic hot taste or

pungency. The previous studies reported the average of this herb's consumption in several countries such as 2500 mg/person/day in India, 5000 mg/person/day in Thailand, 15,500 mg/person/day in Saudi Arabia, and 20,000 mg/person/day in Mexico.^[23,24]

CHEMICAL STRUCTURE

Al Othman *et al.*^[24] investigated the varieties of *Capsicum annum* including hot, red, and green chili and green, red, and yellow pepper that were collected from Saudi Arabia, and they analyzed the content of capsaicin and level of pungency in the Scoville Heat Unit (SHU). They reported the highest of capsaicin content and level of pungency found in hot chili. The following levels are hot chili (4249 μ g/g) > red chili (309 μ g/g) > green chili (139 μ g/g) > green pepper (1 μ g/g) > red pepper and yellow pepper (not detected). They also reported the pungency level in the following order: hot chili (67985 SHU) > red chili (4949 SHU) > green chili (2217 SHU) > green pepper (16 SHU) > red pepper and yellow pepper (less pungent).

TRADITIONAL USES

The traditional uses or phytochemical properties of capsaicin from several literature reviews are described antibacterial,^[25,26] anticancer,^[27,28] antidiabetic,^[29,30] antifungal,^[31,32] antihypertensive,^[33,34] anti-inflammation,^[35-37] antioxidant,^[38,39] and antipain activities.^[40-42] Moreover, it can be used for the treatment of cardiovascular^[43,44] and hepatic diseases.^[45,46]

MECHANISM OF ANTI-OBESITY PROPERTY OF CAPSAICIN

Suppressing appetite and inducing satiety

Reinbach *et al.*^[47] from Denmark evaluated in 27 participants who ingested capsaicin and found that this substance can reduce the energy

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intake during positive energy balance. It also suppressed hunger and induced satiety more during negative than during positive energy balance. Janssens *et al.*^[48] from the Netherlands evaluated in fifteen participants (7 women and 8 men, mean age 29.7 years and BMI 23.3 kg/m²) who ingested the 2.56 mg capsaicin or equal of 39,050 SHU of red chili. They reported that the capsaicin increased satiety and fullness and tended to inhibit overeating when food intake was *ad libitum* and also prevented the effect of the negative energy balance on desire to eat.

Enhancing lipid metabolism

Kang *et al.*^[49] from Korea investigated the effect of 0.015% capsaicin in dietary supplement for 10 weeks in obese mice fed a high-fat diet. They reported that it can inhibit insulin resistance and fat accumulation in hepatocytes. They reported that capsaicin decreased the level of fasting glucose, insulin, triglyceride, leptin, tumor necrosis factor- α , interleukin-6, monocyte chemoattractant protein-1, and transient receptor potential vanilloid Type-1. The capsaicin also increased the expression of mRNA of adiponectin, peroxisome proliferator-activated receptor (PPAR)- α , and PPAR- γ coactivator-1 α . Lee *et al.*^[50] from Korea investigated the effect of capsaicin on lipid catabolism in differentiated adipocytes. They reported that capsaicin decreased the intracellular lipid content and expressed multiple genes involved in lipid catabolism such as hormone-sensitive lipase, carnitine palmitoyltransferase, and involved in thermogenesis such as a uncoupling protein-2 gene. Moreover, Lee *et al.*^[51] reported the tropical application of 0.075% capsaicin to male mice fed on a high-fat diet significantly decreased weight gain, decreased lipid accumulation in the mesenteric and epididymal adipose tissues. The capsaicin can decrease serum levels of glucose, cholesterol, and triglyceride. It also induced the expression of adiponectin, adipokines including PPAR both alpha and gamma types, visfatin, and adipon. Moreover, the capsaicin decreased the expression of tumor necrosis factor- α and interleukin-6. These results indicated that tropical application of capsaicin can decrease lipid accumulation in adipose tissues and decrease inflammatory process; in addition, capsaicin can increase insulin sensitivity in an animal model. Tan *et al.*^[52] from China reported that capsaicin decreased body weight, body fat, serum lipids such as triglyceride, low-density lipoprotein, and high-density lipoprotein in the obese rat. The capsaicin upregulates the expression of PPAR in both alpha and gamma types, uncoupling protein-2 gene and adiponectin. It also downregulates the expression of leptin.

Enhancing thermogenesis

Joo *et al.*^[53] studied the effect of 10 mg/kg of capsaicin in 5-week-old rats fed with high-fat diet. They reported that the body weight decreased 8% in the capsaicin-treated group. The capsaicin downregulates heat shock protein-27 and STEAP3 protein, as well as upregulates the olfactory receptor in obese white adipose tissue. The capsaicin decreases the levels of vimentin and peroxiredoxin, whereas it increases the levels of aldo-keto reductase and flavoprotein. These researchers suggested that capsaicin increases thermogenesis and lipid metabolism for inhibition of obesity. Janssens *et al.*^[48] from the Netherlands reported that a little add capsaicin in food (approximately 0.002 g) has a trend to increase energy expenditure and also reduce energy and fat intake.

Inhibiting pancreatic lipase and α -amylase activity

Baek *et al.*^[54] from Korea investigated the antiobesity properties of aqueous extracts of seven varieties of *C. annuum*. The antiobesity properties were examined through the study of lipoprotein lipase level in mouse preadipocytes. They reported among seven varieties; oyee gochu, green pepper, yellow paprika, and red paprika tended to increase the level of lipoprotein lipase. While Putgochu, Kwari putgochu, and Cheongyang

gochu showed decrease the level of lipoprotein lipase in 10%, 20%, and 50%, respectively. Feng *et al.*^[55] from China studied the effect of capsaicin inhibited the proliferation and differentiation of preadipocytes. The capsaicin also inhibited the accumulation of intracellular triglyceride. It also decreased the expression of lipoprotein lipase, leptin, and PPAR- γ type.

Inhibiting α -amylase activity

Watcharachaisoponsiri *et al.*^[56] from Thailand reported that the α -amylase inhibitory activity from different commercially chili pepper extracts including yellow pepper, green pepper, cayenne pepper, red chinda pepper, green chinda pepper, young pepper, chili spur pepper, sweet pepper, and bird chili. They reported that the 70:30 aqueous:ethanol extraction of 5 mg/ml of sweet pepper had the highest 66% α -amylase inhibitory activity, whereas cayenne pepper had the lowest 23% activity.

Preventing adipocyte differentiation

Jeong *et al.*^[57] reported that 0.1, 1, 5, and 10 micromole of capsaicin can decrease lipid accumulation during adipocyte differentiation of bovine bone marrow mesenchymal stem cells for 2, 4, and 6 days. Capsaicin also inhibited the expression of PPAR- γ , fatty acid binding protein, and stearoyl-CoA desaturase (SCD). Ibrahim *et al.*^[58] reported capsaicin inhibited the adipogenic differentiation of mesenchymal stem cells by repressing PPAR- γ , C/EBP α , FABP4, and SCD-1 gene expression.

CONCLUSION

Capsaicin is a bioactive compound that can be found in the fruits of the plant genus *Capsicum*. It shown potential property as antiobesity substance through several mechanisms, for example, induce body weight reduction, induce lipolysis in adipocytes, induce satiety or sensation of fullness, induce energy expenditure, and also reduce energy and fat intake. The present reviews summarized here suggest that the association of capsaicin consumption may have a change to prevent and use for obesity therapy.

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Conflicts of interest

There are no conflicts of interest.

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