Pharmacogn. Rev.
A multifaceted peer reviewed journal in the field of Pharmacognosy and Natural Products
www.phcogrev.com | www.phcog.net

REVIEW ARTICLE

Current Understanding of Antiobesity Property of Capsaicin

Nithida Narang, Wannee Jiraungkoorskul[1], Parinda Jamrus[1]

Mahidol University International College, Mahidol University, Salaya Campus, Nakhon Pathom, [1]Department of Pathobiology, Faculty of Science, Mahidol University, Bangkok, Thailand

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/m^2.[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 ($C_{18}H_{27}NO_3$, 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]

Correspondence:
Dr. Wannee Jiraungkoorskul,
Department of Pathobiology, Faculty of Science,
Mahidol University, Bangkok 10400, Thailand.
E-mail: pathobiologymu@gmail.com

Access this article online	
Quick Response Code:	Website: www.phcogrev.com
	DOI: 10.4103/phrev.phrev_48_16

CHEMICAL STRUCTURE

Al Othman *et al.*[24] investigated the varieties of *Capsicum annuum* 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 μg/g) > red chili (309 μg/g) > green chili (139 μg/g) > green pepper (1 μg/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 ANTIOBESITY 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

Cite this article as: Narang N, Jiraungkoorskul W, Jamrus P. Current understanding of antiobesity property of capsaicin. Phcog Rev 2017;11:23-6.

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/m^2) 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-1α. 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 adipsin. Moreover, the capsaicin decreased the expression of tumor necrosis factor-α and interlukin-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/EBPα, 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.

Acknowledgement

A special thanks to the members of the Fish Research Unit, Department of Pathobiology, Faculty of Science, Mahidol University, for their support. The author would like to thank anonymous reviewers and editors of this review article for their perceptive comments and positive criticism in this review article.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Jitnarin N, Kosulwat V, Rojroongwasinkul N, Boonpraderm A, Haddock CK, Poston WS. Risk factors for overweight and obesity among Thai adults: Results of the National Thai Food Consumption Survey. Nutrients 2010;2:60-74.
2. Harijono A, Puryatni A, Cahyono H, Yosoprawoto M. Prevalence and risk factors of overweight and obesity in adolescents in Malang, East Java-Indonesia. Int J Pediatr Endocrinol 2013;2013 (Suppl 1):50.
3. Nasreddine L, Naja F, Chamieh MC, Adra N, Sibai AM, Hwalla N. Trends in overweight and obesity in Lebanon: Evidence from two national cross-sectional surveys (1997 and 2009). BMC Public Health 2012;12:798.

4. Baretic M. Obesity drug therapy. Minerva Endocrinol 2013;38:245-54.
5. Rodgers RJ, Tschöp MH, Wilding JP. Anti-obesity drugs: Past, present and future. Dis Model Mech 2012;5:621-6.
6. Halford JC. Pharmacology of appetite suppression: Implication for the treatment of obesity. Curr Drug Targets 2001;2:353-70.
7. Perry B, Wang Y. Appetite regulation and weight control: The role of gut hormones. Nutr Diabetes 2012;2:e26.
8. Amin T, Mercer JG. Hunger and satiety mechanisms and their potential exploitation in the regulation of food intake. Curr Obes Rep 2016;5:106-12.
9. Cao S, Chen H, Xiang S, Hong J, Weng L, Zhu H, *et al.* Anti-cancer effects and mechanisms of capsaicin in chili peppers. Am J Plant Sci 2015;6:3075-81.
10. Pola A, Sadananthan SA, Gopalan V, Tan ML, Keong TY, Zhou Z, *et al.* Investigation of fat metabolism during antiobesity interventions by magnetic resonance imaging and spectroscopy. Magn Reson Insights 2014;7:33-40.
11. Meiliana A, Wijaya A. Brown adipose tissue: A new target for antiobesity therapy. Indones Biomed J 2010;2:4-15.
12. Clapham JC, Arch JR. Targeting thermogenesis and related pathways in anti-obesity drug discovery. Pharmacol Ther 2011;131:295-308.
13. Sukhdev S, Singh K. Therapeutic role of phytomedicines on obesity: Importance of herbal pancreatic lipase inhibitors. Int Res J Med Sci 2013;1:15-26.
14. Lunagariya N, Patel N, Jagtap S, Bhutani K. Inhibitors of pancreatic lipase: State of the art and clinical perspectives. Exp Clin Sci J 2014;13:897-921.
15. del Castillo-Santaella T, Maldonado-Valderrama J, Cabrerizo-Vílchez MÁ, Rivadeneira-Ruiz C, Rondón-Rodriguez D, Gálvez-Ruiz MJ. Natural inhibitors of lipase: Examining lipolysis in a single droplet. J Agric Food Chem 2015;63:10333-40.
16. Singh G, Suresh S, Bayineni V, Kadeppagari R. Lipase inhibitors from plants and their medical applications. Int J Pharm Pharm Sci 2015;7:1-5.
17. Narkhede M. Evaluation of alpha amylase inhibitory potential of four traditional culinary leaves. Asian J Pharm Clin Res 2012;5:75-6.
18. Sales PM, Souza PM, Simeoni LA, Silveira D. α-amylase inhibitors: A review of raw material and isolated compounds from plant source. J Pharm Pharm Sci 2012;15:141-83.
19. Marrelli M, Loizzo M, Nicoletti M, Menichini F, Conforti F. *In vitro* investigation of the potential health benefits of wild Mediterranean dietary plants as anti-obesity agents with α-amylase and pancreatic lipase inhibitory activities. J Sci Food Agric 2014;94:2217-24.
20. Daquinag AC, Zhang Y, Kolonin MG. Vascular targeting of adipose tissue as an anti-obesity approach. Trends Pharmacol Sci 2011;32:300-7.
21. Han J, Wei L, Xu W, Lu J, Wang C, Bao Y, *et al.* CTSK inhibitor exert its anti-obesity effects through regulating adipocyte differentiation in high-fat diet induced obese mice. Endocr J 2015;62:309-17.
22. Morales-Martínez C, Márquez-Aguirre A, Díaz-Martínez E, Rodríguez-González J, Mateos-Díaz J, Esquivel-Solís H, *et al.* The prospective antiobesity effect of capsaicin synthetic analogs: A matter of weight. Med Chem 2016;6:365-71.
23. López-Carrillo L, Hernández Avila M, Dubrow R. Chili pepper consumption and gastric cancer in Mexico: A case-control study. Am J Epidemiol 1994;139:263-71.
24. Al Othman ZA, Ahmed YB, Habila MA, Ghafar AA. Determination of capsaicin and dihydrocapsaicin in *Capsicum* fruit samples using high performance liquid chromatography. Molecules 2011;16:8919-29.
25. Nascimento P, Nascimento T, Ramos N, Silva G, Camara C, Silva T, *et al.* Antimicrobial and antioxidant activities of *Pimenta malagueta* (*Capsicum frutescens*). Afr J Microbiol Res 2013;7:3526-33.
26. Sia Su G, David P, Tan L, Sia Su M, Sison M, Ragragio E, *et al.* Phytochemical screening and antimicrobial activity of *Capsicum frutescens* Linn. crude fruit extract on selected microorganisms. J Pharm Biomed Sci 2013;37:1922-6.
27. Park SY, Kim JY, Lee SM, Jun CH, Cho SB, Park CH, *et al.* Capsaicin induces apoptosis and modulates MAPK signaling in human gastric cancer cells. Mol Med Rep 2014;9:499-502.
28. Cho AS, Jeon SM, Kim MJ, Yeo J, Seo KI, Choi MS, *et al.* Chlorogenic acid exhibits anti-obesity property and improves lipid metabolism in high-fat diet-induced-obese mice. Food Chem Toxicol 2010;48:937-43.
29. Chaiyasit K, Khovidhunkit W, Wittayalertpanya S. Pharmacokinetic and the effect of capsaicin in *Capsicum frutescens* on decreasing plasma glucose level. J Med Assoc Thai 2009;92:108-13.
30. Okumura T, Tsukui T, Hosokawa M, Miyashita K. Effect of caffeine and capsaicin on the blood glucose levels of obese/diabetic KK-A(y) mice. J Oleo Sci 2012;61:515-23.
31. De Lucca AJ, Boue S, Palmgren MS, Maskos K, Cleveland TE. Fungicidal properties of two saponins from *Capsicum frutescens* and the relationship of structure and fungicidal activity. Can J Microbiol 2006;52:336-42.
32. Soumya S, Nair B. Antifungal efficacy of *Capsicum frutescens* L. extracts against some prevalent fungal strains associated with groundnut storage. J Agric Technol 2012;8:739-50.
33. Harada N, Okajima K. Effects of capsaicin and isoflavone on blood pressure and serum levels of insulin-like growth factor-I in normotensive and hypertensive volunteers with alopecia. Biosci Biotechnol Biochem 2009;73:1456-9.
34. Patanè S, Marte F, La Rosa FC, La Rocca R. Capsaicin and arterial hypertensive crisis. Int J Cardiol 2010;144:e26-7.
35. Kim CS, Kawada T, Kim BS, Han IS, Choe SY, Kurata T, *et al.* Capsaicin exhibits anti-inflammatory property by inhibiting IkB-a degradation in LPS-stimulated peritoneal macrophages. Cell Signal 2003;15:299-306.
36. Jolayemi AT, Ojewole JA. Comparative anti-inflammatory properties of capsaicin and ethyl-aAcetate extract of *Capsicum frutescens* Linn. [*Solanaceae*] in rats. Afr Health Sci 2013;13:357-61.
37. Kim Y, Lee J. Anti-inflammatory activity of capsaicin and dihydrocapsaicin through heme oxygenase-1 induction in raw264.7 macrophages. J Food Biochem 2014;38:381-7.
38. Hassan MH, Edfawy M, Mansour A, Hamed AA. Antioxidant and antiapoptotic effects of capsaicin against carbon tetrachloride-induced hepatotoxicity in rats. Toxicol Ind Health 2012;28:428-38.
39. Viktorija M, Liljana K, Tatjana R, Ana C, Rubin G. Antioxidative effect of *Capsicum* oleoresins compared with pure capsaicin. Int Organ Sci Res J Pharm 2014;4:44-8.
40. Mason L, Moore RA, Derry S, Edwards JE, McQuay HJ. Systematic review of topical capsaicin for the treatment of chronic pain. BMJ 2004;328:991.
41. Anand P, Bley K. Topical capsaicin for pain management: Therapeutic potential and mechanisms of action of the new high-concentration capsaicin 8% patch. Br J Anaesth 2011;107:490-502.
42. Üçeyler N, Sommer C. High-dose capsaicin for the treatment of neuropathic pain: What we know and what we need to know. Pain Ther 2014;3:73-84.
43. Fragasso G, Palloshi A, Piatti PM, Monti L, Rossetti E, Setola E, *et al.* Nitric-oxide mediated effects of transdermal capsaicin patches on the ischemic threshold in patients with stable coronary disease. J Cardiovasc Pharmacol 2004;44:340-7.
44. Patanè S, Marte F, Di Bella G, Cerrito M, Coglitore S. Capsaicin, arterial hypertensive crisis and acute myocardial infarction associated with high levels of thyroid stimulating hormone. Int J Cardiol 2009;134:130-2.
45. Abdel-Salam O, Sleem A, Hassan N, Sharaf H, Gy M. Capsaicin ameliorates hepatic injury caused by carbon tetrachloride in the rat. J Pharmacol Toxicol 2006;1:147-56.
46. Mohammed F, Sultan A, Abas A. Chemopreventive and therapeutic effect of capsaicin against diethylnitrosamine induced liver injury and hepatocellular carcinoma in rats. Int J Biol Pharm Res 2014;5:630-42.
47. Reinbach HC, Smeets A, Martinussen T, Møller P, Westerterp-Plantenga MS. Effects of capsaicin, green tea and CH-19 sweet pepper on appetite and energy intake in humans in negative and positive energy balance. Clin Nutr 2009;28:260-5.
48. Janssens PL, Hursel R, Westerterp-Plantenga MS. Capsaicin increases sensation of fullness in energy balance, and decreases desire to eat after dinner in negative energy balance. Appetite 2014;77:44-9.
49. Kang JH, Goto T, Han IS, Kawada T, Kim YM, Yu R. Dietary capsaicin reduces obesity-induced insulin resistance and hepatic steatosis in obese mice fed a high-fat diet. Obesity (Silver Spring) 2010;18:780-7.
50. Lee MS, Kim CT, Kim IH, Kim Y. Effects of capsaicin on lipid catabolism in 3T3-L1 adipocytes. Phytother Res 2011;25:935-9.
51. Lee GR, Shin MK, Yoon DJ, Kim AR, Yu R, Park NH, *et al.* Topical application of capsaicin reduces visceral adipose fat by affecting adipokine levels in high-fat diet-induced obese mice. Obesity (Silver Spring) 2013;21:115-22.
52. Tan S, Gao B, Tao Y, Guo J, Su ZQ. Antiobese effects of capsaicin-chitosan microsphere (CCMS) in obese rats induced by high fat diet. J Agric Food Chem 2014;62:1866-74.
53. Joo JI, Kim DH, Choi JW, Yun JW. Proteomic analysis for antiobesity potential of capsaicin on white adipose tissue in rats fed with a high fat diet. J Proteome Res 2010;9:2977-87.
54. Baek J, Lee J, Kim K, Kim T, Kim D, Kim C, *et al.* Inhibitory effects of *Capsicum annuum* L. water extracts on lipoprotein lipase activity in 3T3-L1 cells. Nutr Res Pract 2013;7:96-102.

55. Feng Z, Hai-ning Y, Xiao-man C, Zun-chen W, Sheng-rong S, Das UN. Effect of yellow *Capsicum* extract on proliferation and differentiation of 3T3-L1 preadipocytes. Nutrition 2014;30:319-25.

56. Watcharachaisoponsiri T, Sornchan P, Charoenkiatkul S, Suttisansanee U. The α-glucosidase and α-amylase inhibitory activity from different chili pepper extracts. Int Food Res J 2016;23:1439-45.

57. Jeong JY, Suresh S, Park MN, Jang M, Park S, Gobianand K, *et al*. Effects of capsaicin on adipogenic differentiation in bovine bone marrow mesenchymal stem cell. Asian Australas J Anim Sci 2014;27:1783-93.

58. Ibrahim M, Jang M, Park M, Gobianand K, You S, Yeon SH, *et al*. Capsaicin inhibits the adipogenic differentiation of bone marrow mesenchymal stem cells by regulating cell proliferation, apoptosis, oxidative and nitrosative stress. Food Funct 2015;6:2165-78.