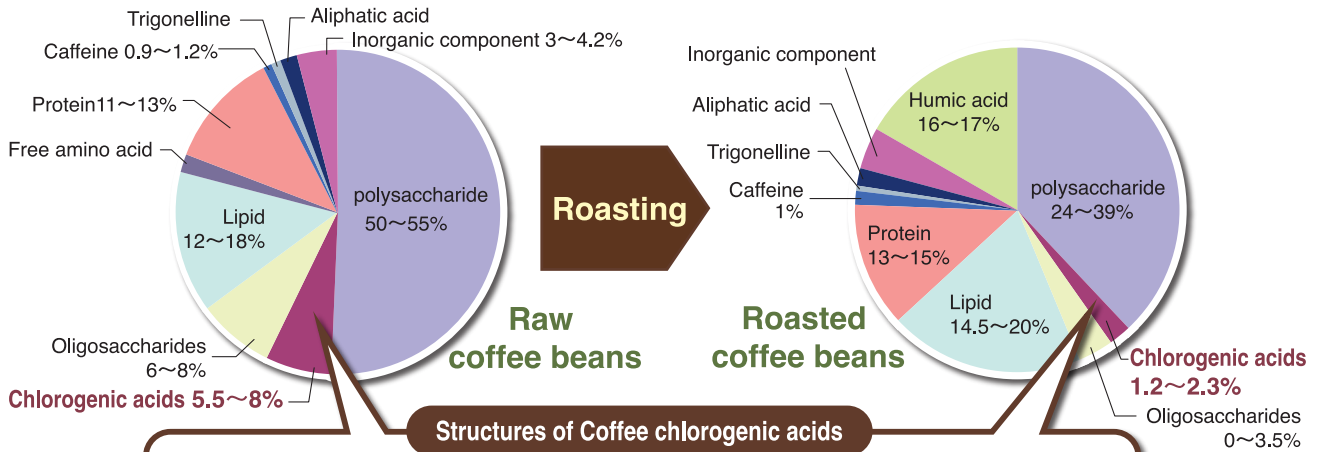


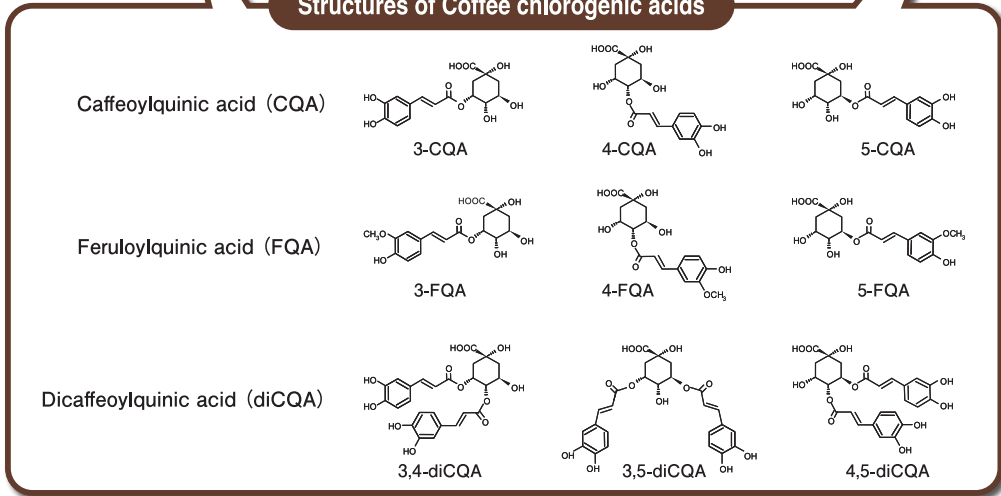


# Coffee chlorogenic acids contained in coffee beans

## Changes in composition due to roasting of Arabica coffee beans



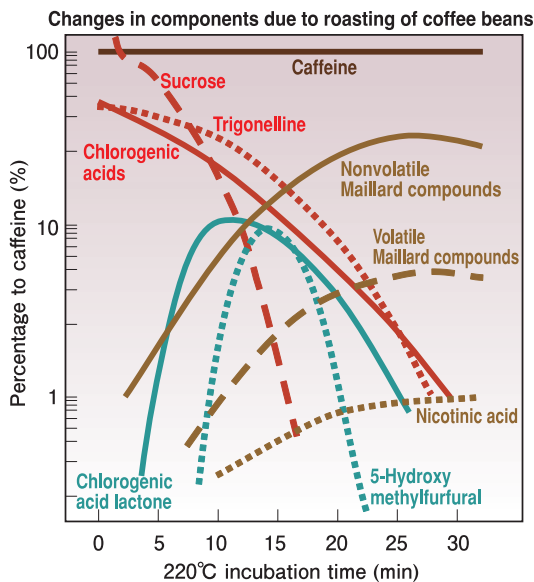
### Structures of Coffee chlorogenic acids



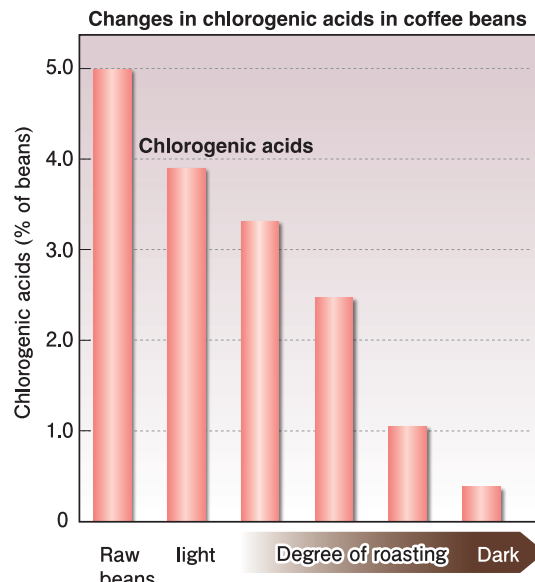
(Toshiro Nakabayashi et al., "Chemistry and Technology of Coffee Cultivation", Kougaku Publishing, 1995)

# Chemical composition that changes with roasting

Coffee roasting is a process of developing the flavors and other aroma compounds of coffee by heating at a temperature of 200°C or higher for a period of time. Chlorogenic acids are typical polyphenols in coffee beans, however dramatically decrease during the roasting process.



Kitaro Oka, Yakugaku Zasshi, 127, 1825-1836, 2007



Survey by Kao



# Effects on blood pressure via continuous intake

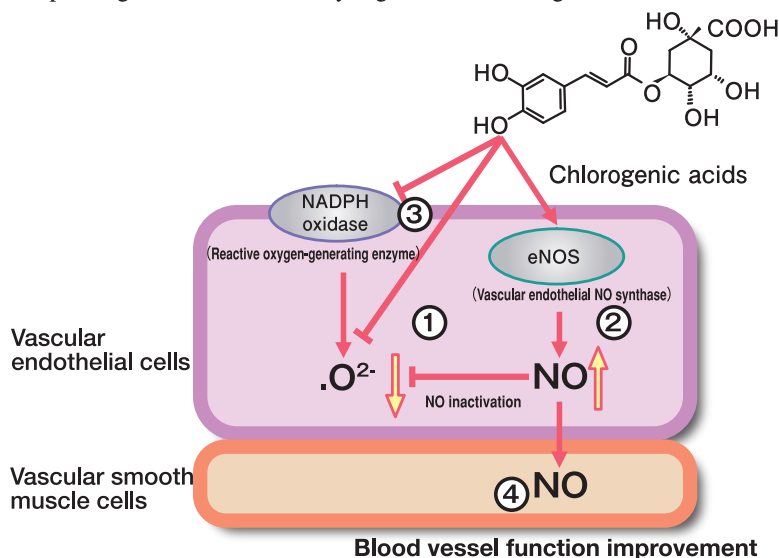
## Mechanism of action of chlorogenic acids on vascular endothelium

### 1. Action mechanism of chlorogenic acids on vascular endothelial cells

The following three findings have been confirmed as effects of chlorogenic acids and their in vivo metabolites on vascular endothelial cells. ① action by chlorogenic acids removing active oxygen<sup>1)</sup>, ② action by activation of eNOS (vascular endothelial nitric oxide synthase)<sup>2)</sup>, ③ action by inhibition of NADPH oxidase (reactive oxygen generating enzyme)<sup>3)</sup>. All of these actions are presumed to act to improve the bioavailability of nitric oxide (NO) in vascular endothelial cells.

### 2. Improvement of vascular endothelial function by chlorogenic acids

From the above, it was shown that NO is involved in the improvement of vascular endothelial function by chlorogenic acids. ④ NO, a vasorelaxing factor derived from vascular endothelial cells, is considered to be involved in the action mechanism of improving vascular function by ingestion of chlorogenic acids<sup>4,5)</sup>.

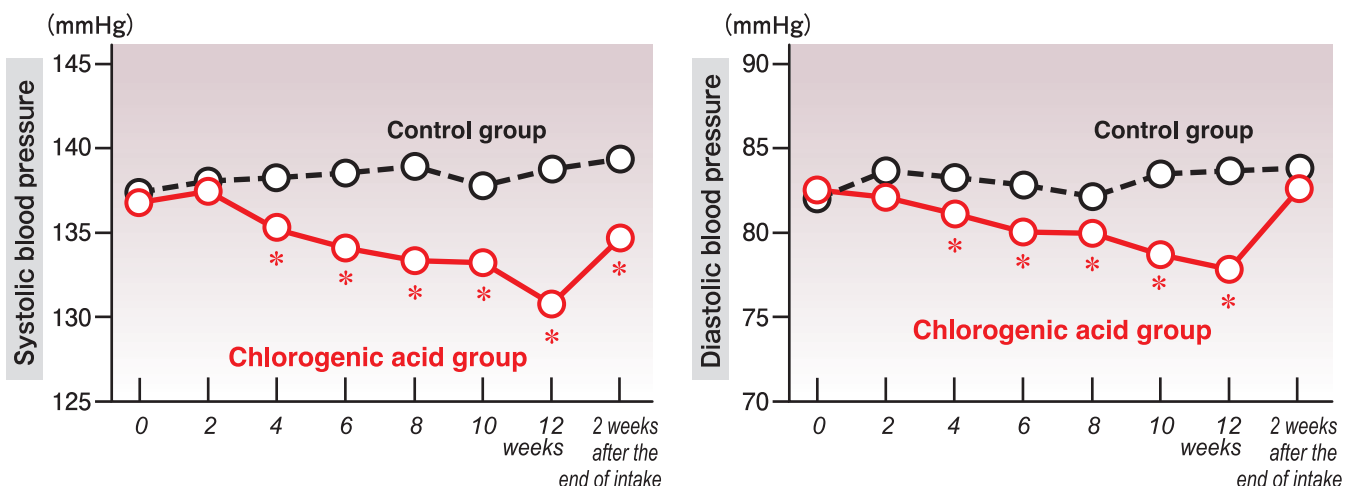


- 1) Suzuki A. et al., Am J Hypertens, 20, 508-513, 2007
- 2) Hou YZ. et al., J Cell Biochem, 93, 1203-1209, 2004
- 3) Suzuki A. et al., FEBS Letters, 508, 2317-2322, 2006
- 4) Suzuki A. et al., J Hypertens, 24, 1065-1073, 2006
- 5) Suzuki A. et al., Am J Hypertens, 15, 351-357, 2002

## Effects of continuous intake of chlorogenic acids on blood pressure in human study

A 12-week parallel-group study. Subjects: 88 men and women with high blood pressure (systolic blood pressure 130-139mmHg or diastolic blood pressure 85-89 mmHg)

- Control group: chlorogenic acids 0 mg/day
- Chlorogenic acid group: chlorogenic acids 271 mg/day



Control group n=43, chlorogenic acid group n=45, Mean ± standard error

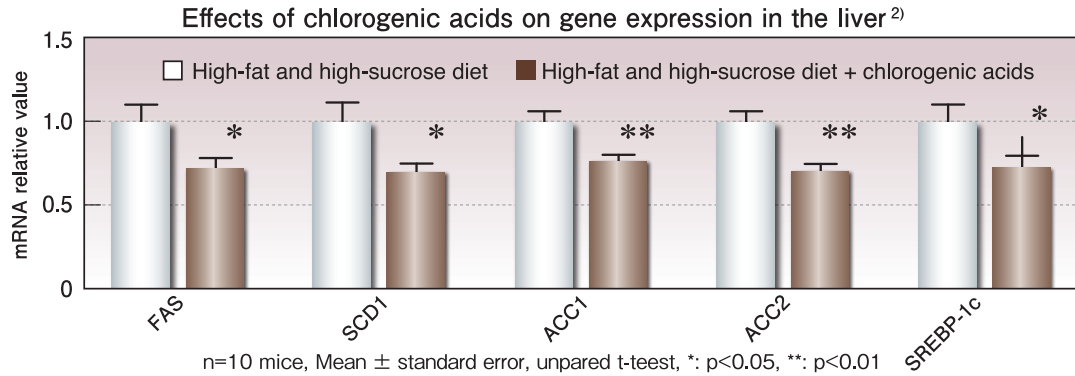
\*p<0.05 (compared with control group)

Yamaguchi et al., Prog.Med, 27, 683-694, 2007



## Mechanism of action of chlorogenic acids on fat burning enhancement

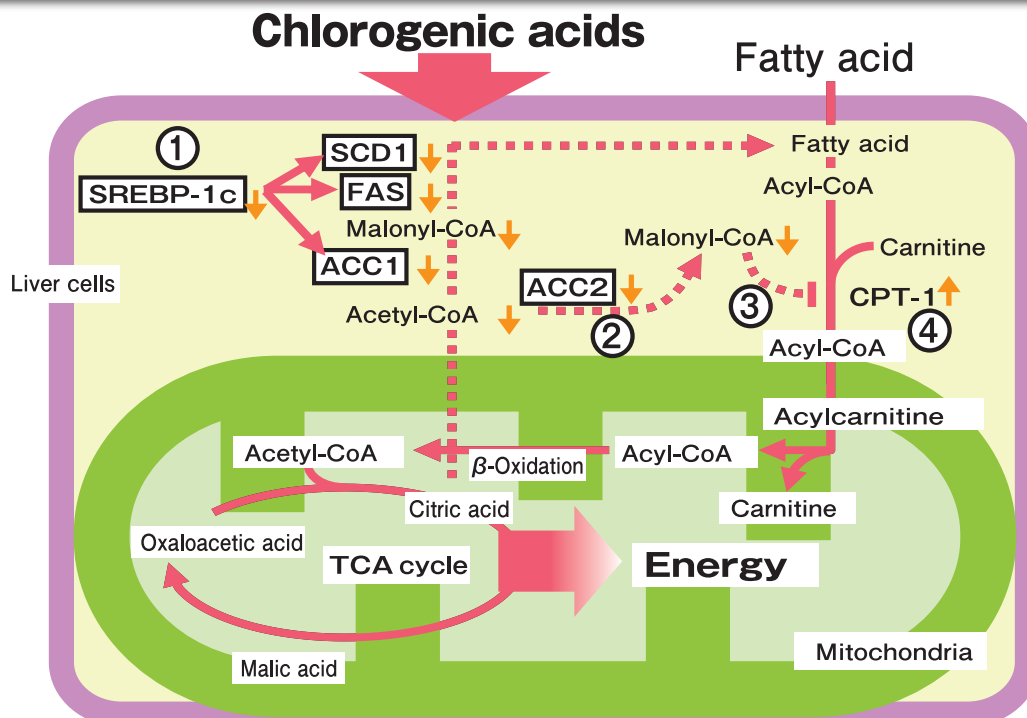
The mechanism of action of chlorogenic acids in reducing body fat is considered to be "fat consumption enhancement", that is, fat becomes easier to be consumed as energy<sup>1)</sup>. It is presumed that the fat consumption-enhancing action is due to the fact that the ingestion of chlorogenic acids might enhance the burning of fatty acids mainly in the liver<sup>2)</sup>.



### Mechanism of enhancement of fatty acid burning during continuous intake of chlorogenic acids

- ① In the liver, mRNA expressions SREBP-1 (sterol element-binding protein-1c), SCD1 (steroyl-CoA desaturase 1), FAS (fatty acid synthase), ACC1 (acetyl-CoA carboxylase 1), ACC2 (acetyl-CoA carboxylase 2) were significantly reduced. It has been reported that suppression of the expression of ACC1 and SCD1 in the fatty acid synthesis system induces an increase in energy consumption<sup>3-6)</sup>.
- ② Decreased expression of ACC2 reduces the production of malonyl-CoA, which inhibits CPT-1\* (carnitine palmitoyltransferase-1).
- ③ The decrease in malonyl-CoA increases the activity of CPT-1.
- ④ By increasing the activity of CPT-1, transport of fatty acids into the mitochondria is increased, and fatty acid combustion is enhanced<sup>2)</sup>.

\*CPT-1 is an enzyme that converts acyl-CoA along with carnitine to acyl-carnitine, and catalyzes the first step in long-chain fatty acid import into mitochondria to enhance fatty acid combustion. The activity is inhibited by malonyl-CoA, a reaction product of ACC2.



1) Ota N. et al., J Health Sci, 56, 745-751, 2010

2) Murase T. et al., Am J Physiol Endocrinol Metab, 300, E122-E133, 2011

3) Dobrzyn A. et al., Trends Cardiovasc Med, 14, 77-81, 2004

4) Mao J. et al., Proc Natl Acad Sci USA, 103, 8552-8557, 2006

5) Savage DB. et al., J Clin Invest, 116, 817-824, 2006

6) Ntambi JM. et al., Proc Natl Acad Sci USA, 99, 11482-11486, 2002

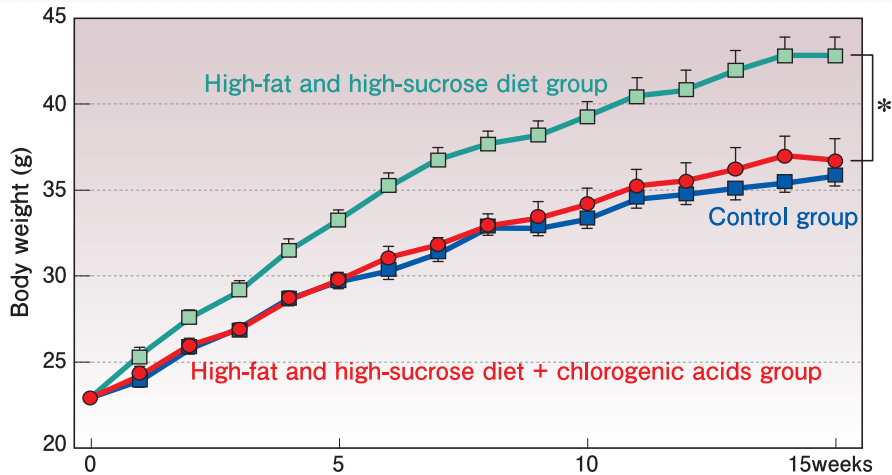


## Effects on body fat via continuous intake

### Effects of continuous intake of chlorogenic acids on body weight in animal study

Diet-dependent obesity model mice (C57BL/6J mice) were continuously administered each test diet for 15 weeks, and observed changes in body weight

- Control group: continuous administration of normal food
- High-fat and high-sucrose diet group: continuous administration of high-fat and high-sucrose diet
- High-fat and high-sucrose diet + chlorogenic acids group: continuous administration of 1% roasted coffee bean extract added to high-fat and high-sucrose diet

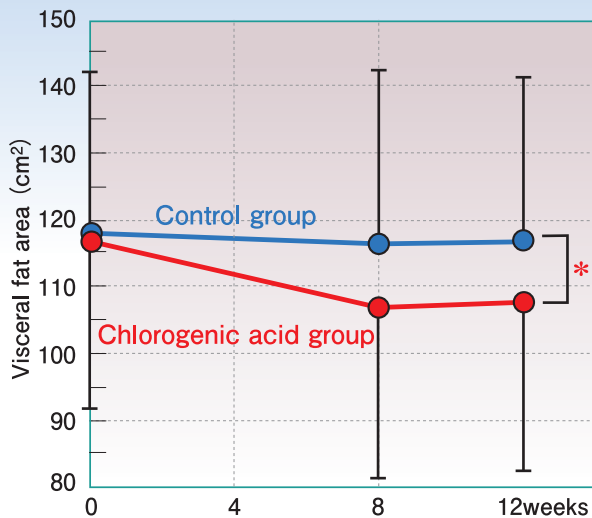


n=10 mice, Mean  $\pm$  standard error, two-way ANOVA, \*:  $p < 0.05$ ,  
High-fat and high-sucrose diet group + chlorogenic acids group vs high-fat and high-sucrose diet group  
Murase T. et al., Am J Physiol Endocrinol Metab, 300, E122-E133, 2011

### Effects of continuous intake of chlorogenic acids on reducing visceral fat human study

A 12-week parallel-group study. Subjects: 142 males and females aged 20 to 65 y, BMI 25-30 kg/m<sup>2</sup>, visceral fat area of 80 cm<sup>2</sup> or more by CT tomographic diagnosis.

- Control group: chlorogenic acids 30 mg/day
- Chlorogenic acid group: chlorogenic acids 319 mg/day

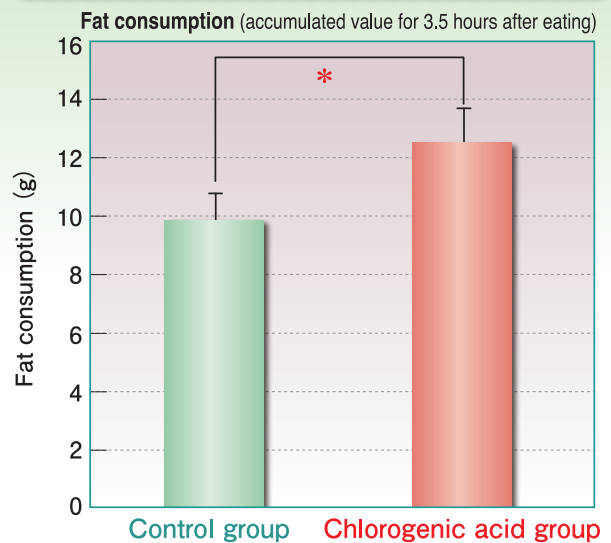


Control group n=70, chlorogenic acid group n=72,  
Mean  $\pm$  standard deviation, repeated measures ANOVA, \*  $p < 0.001$   
Watanabe et al., Nutrients, 11, 1617-, 2019

### Effects of continuous intake of chlorogenic acids on fat consumption in human study

One week crossover trial. Subjects: 7 males with an average age of 34.7y and a BMI of 21.8 kg/m<sup>2</sup>. Breath analysis measurements after drinking the test drink at the beginning of intake and at the end of the first week.

- Control group: chlorogenic acids 0 mg/day
- Chlorogenic acid group: chlorogenic acids 359 mg/day



n=7, Mean  $\pm$  standard error, paired t-test, \*:  $p < 0.05$   
Ota N. et al., J Health Sci, 56, 745-751, 2010