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Editorial

Green tea: a tea or a remedy?

All teas contain polyphenols. Polyphenols obtained from tea have been well known to have antioxidative properties observed by laboratory experiments. Actually, plant phytochemicals including polyphenols are responsible for the protection of their fruits against the strong ultraviolet light from the sun. Likewise, in animals, they scavenge oxygen- and nitrogen-free radicals, thereby protecting lipid membranes, proteins, and DNA. Overall, they have been shown to have many biological activities that are helpful for the treatment of human degenerative diseases, in particular, cancer prevention. The most well-known polyphenol to prevent various diseases is epigallocatechin-3-gallate (EGCG), which is the most abundant form in green tea extracts (GTEs). Polyphenols comprise the major portion of phytochemicals produced by plants, and phytochemicals contain carotenoid, inositol, lignan, indole, terpene, etc., as well as polyphenols. Polyphenols are divided into nonflavonoids and flavonoids, the latter of which contain anthocyanins, proanthocyanins, hesperidin, quercetin, rutin, isoflavone, catechins, theaflavin, chlorogenic acid, cineole, sesaminol, etc. Flavonoids (from the Latin word *flavus*, meaning yellow) are known to have antiallergic,[1] anti-inflammatory,[1,2] antioxidant,[2] antimicrobial,[3–6] anticancer,[2,7] and antidiarrheal activities[8] as shown by various *in vitro* experiments. However, their *in vivo* effects have not been proven in humans. One reason for this may be their lower bioavailability in humans (less than 5%). Therefore, as introduced in this edition, the trials to increase their human bioavailability have been also investigated. I would like to briefly introduce the contents of this special edition of the review for green tea for a better understanding of the readers. In summary, I would like to mention here that the effects of polyphenols in plants may be different than those observed in animals and *in vitro* studies, because GTE's effects on animal biological systems is not exactly applicable to *in vivo* studies. Additionally, the effects of GTEs in animals is not the same as those in humans. Regardless of the reasons, including the different bioavailability and metabolism among animal species, we should acknowledge that GTEs cannot be a sole remedy for certain diseases, but could be a supplement unless the side effects of GTE intake are ignored and someone is satisfied with green tea intake as a favorite daily tea.

Natural products including phytochemicals have been extensively investigated for the development of skin care strategies. GTE is one of them and is now commercially used as an ingredient of skin care cosmetics. With reactive oxygen species (ROS) being a major cause of skin aging,[9] GTE has been attracting the attention of the cosmetics industry because it has a strong antioxidative activity.[10,11] In addition, GTE has been known to be an inhibitor of skin collagenase, tyrosinase, and elastase activity,[12–14] which hinder normal skin contour and skin whitening. Suh and co-authors introduce tannase-converted GTE on skin care. Tannase is an enzyme used to hydrolyze the gallate ester bond of EGCG and ECG, converting them to EGC and EC, respectively. These authors and Lu and Chen[15] reported that the tannase treatment of GTE enhances the effects of GTE on ROS scavenging, although the concentration of caffeine is not affected. The pH of the regimen by tannase becomes acidic to provide similar condition to the normal skin surface and resistance to foreign pathogens. Also, tannase treatment offers the higher permeability of GTE to the skin barrier, because EC and EGC permeate the skin more effectively than EGCG and ECG can. Moreover, EGCG and ECG, although they do not have higher permeability to the skin, can exert their effects on antibacterial activity and protein and lipid affinity on skin, which are helpful for skin care and maintenance. At any rate, if there is a limitation for GTE to be absorbed into the circulation, it would be recommendable to use GTE for skin cosmetics.

Chemoprevention of cancer using natural and synthetic materials has been studied to prevent carcinogenesis and metastasis. EGCG has been known to be effective in various cancers. The main mechanism may be divided into induction of cell death and inhibition of metastasis. The cytotoxicity of EGCG is attributable to its ROS generation and various cellular signal modulations. The metastasis blockage of EGCG is due to its inhibition of various matrix metalloproteinases (MMPs).[16] Kato et al. present a report[17] demonstrating an important target of EGCG on cancer metastasis at the upstream of MMPs, called the tumor suppressor RECK gene. HPMCP coating may be used to enhance the bioavailability of GTE in humans, because it protects GTE from gastric acid.[18] However, Chung and co-authors indicate that clinical trials of

GTE or EGCG may not be effective in humans as a chemoprevention against cancers, with cohort studies showing an extraordinary gender-dependent effects of green tea ingestion for head and neck cancer prevention. This may indicate that the *in vivo* anticancer effects of GTE remain to be further determined in humans. Min and Kwon schematically summarize the antitumor mechanism of EGCG in this review. EGCG inhibits carcinogenic activity, tumerogenesis, proliferation, angiogenesis, and tumor cell survival. For these, the authors note that EGCG modulates ROS production,[19,20] NF-κB signaling, MAPK activity, as well as epigenetic modification. However, they also warn that high doses of EGCG may have a harmful effect on hepatocytes and insulin resistance.

Regarding obesity, EGCG can inhibit adipocyte proliferation and differentiation,[21–23] suggesting that total body fat can be decreased by EGCG, resulting in a reduction of body weight. The mechanism of EGCG for a reduction of adipocyte viability is the generation of ROS. However, the dose of EGCG is too high to consume via the oral route in humans without any side effects.[24] Regarding diabetes, GTE or EGCG has been known to render a defense mechanism against oxidative stress possibly to beta cells and insulin-sensitive tissues.[25] Gallated catechins including EGCG and ECG block intestinal sodium-dependent glucose transporter 1,[26] which is the principal mechanism for glucose absorption, and lipid micelle formation[27] in the intestine. Because of the nonselectivity of gallated catechins to block various glucose transporters,[28] they can interfere with normal glucose excursion at the postprandial period into insulin-sensitive tissues, such as liver, muscles, and adipose tissues. GTEs may have some limitation when used as a supportive remedy for diabetes.This special edition is mainly focused on the effects of EGCG or GTE on diabetes, obesity, and cancers as well as skin care. The editor thinks that the major mechanism by which GTE or EGCG exerts its effects on various diseases is the nonspecific inhibition of glucose transporters of gallated catechins. If it is possible to be free of this burden, they may be used as preventative and therapeutic supplements for the treatment of various human diseases as well as aging. Otherwise, people may still find it worthwhile to drink green tea and enjoy its flavor, which could stimulate our reward system in the brain and, secondarily, improve human longevity.

Conflict of interest

The author declares no conflicts of interest.

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