Green Tea Reduces the Formation of AGEs

Green tea extract reduces the amount of AGEs in milk processing.

These days pretty much everyone knows about the beneficial health effects of green tea. It seems that scientists come up with new studies every week showing how green tea improves health. A lot of these just verify things we already know (or think we do), but the effect of green tea on AGEs (Advanced Glycation End products, a result of the Maillard reaction) is a relatively new and interesting question.

Not many studies have been done on green tea and reducing AGEs, but the ones that have been done look promising. From Babu et al.:

Diabetes leads to modification of collagen such as advanced glycation and cross-linking

which play an important role in the pathogenesis of diabetes mellitus. We have investigated the effect of green tea on modification of collagen in streptozotocin (60 mg/kg body weight) induced diabetic rats.

To investigate the therapeutic effect of green tea, treatment was begun six weeks after the onset of diabetes and green tea extract (300 mg/kg body weight) was given orally for 4 weeks. The collagen content, extent of advanced glycation, advanced glycation end products (AGE) and cross-linking of tail tendon collagen were investigated. Green tea reduced the tail tendon collagen content which increased in diabetic rats. Accelerated advanced glycation and AGE in diabetic animals, as detected by Ehrlich's-positive material and collagen linked fluorescence respectively were reduced significantly by green tea. The solubility of tail tendon collagen decreased significantly in diabetic rats indicating a remarkable increase in the cross-linking, whereas green tea increases the solubility of collagen in diabetic rats.

The present study reveals that green tea is effective in reducing the modification of tail tendon collagen in diabetic rats. Thus green tea may have a therapeutic effect in the treatment of glycation induced complications of diabetes.

In short, they fed green tea extract to diabetic rats and noticed it reduced AGEs in their connective tissue. That's good news. Similar results are reported by Ping et al.:

OBJECTIVE: To determine the effects of green tea polyphenols (GTP) on advanced glycation end products (AGEs)-induced proliferation and expression of p44/42 mitogen-activated protein kinase (MAPK) of rat vascular smooth muscle cells (VSMCs).

METHODS: Rat aortic VSMCs isolated and cultured in vitro were stimulated with AGEs in the presence or absence of GTP at different concentrations, followed by quantitative analysis of the cell proliferation with colorimetric assay. The p44/42 MAPK activity was evaluated by immunoblotting technique using anti-p44/42 phospho-MAPK antibody.

RESULTS: Compared with the control cells (without GTP treatment), GTP dose-dependently inhibited AGE-stimulated VSMC proliferation, and the p44/42 MAPK activity was significantly enhanced. The effects of AGEs were antagonized by GTP.

CONCLUSION: GTP can inhibit the AGE-induced proliferation and p44/42 MAPK expression of rat VSMCs.

This time the effect of green tea polyphenols on heart muscle cells was studied; again, AGE production was reduced. The effect was dose-dependent, meaning that the more green tea polyphenols the rats consumed, the less AGEs their muscle cells had. In another heart-related study, Song et al. report the following findings:

In this study, 6-month-old female Sprague–Dawley rats were fed green tea extract (50 mg/100 ml in drinking water) up to the age of 22 months, and the age-associated changes in Maillard-type fluorescence and carbonyl groups in the aortic and skin collagen were compared with those occurring in the water-fed control animals.

Collagen-linked Maillard-type fluorescence was found to increase in both the aortic and skin tissues as animals aged. The age-associated increase in the fluorescence in the aortic collagen was remarkably inhibited by the green tea extract treatment, while that occuring in the skin collagen was not significantly inhibited by the treatment.The collagen carbonyl content also increased in both the aortic and skin tissues as animals aged. In contrast with the case of Maillard-type fluorescence, however, the age-associated increase in the carbonyl content was not inhibited by the green tea extract treatment either in the aortic or skin collagen.

These results suggest that the inhibition of AGE formation in collagen is an important mechanism for the protective effects of tea catechins against cardiovascular diseases. Increases in fluorescence are considered a marker of AGEs; this study shows that rats fed a green tea extract had less AGEs in their aortas. Unfortunately, a similar effect was not noticed in the skin.

Comparing green tea with vitamin C and E and blueberries, Monnier et al. report:

Both green tea and the combination of vitamin C and E were highly efficacious at blocking the age-related increase in tendon-breaking time. Furthermore, green tea also blocked the age-related increase in collagen associated fluorescence without decreasing glycemia or body weight of the animals. Thus, it appears that green tea ingredients have potent anti-AGE properties.

The figures in the study (which are available through the link) show that the combination of vitamin C and E was more effective than green tea in reducing the tendon-breaking time – which increases with age – but less effective than green tea in reducing fluorescence.

Finally, green tea catechins seem to reduce AGEs in heat-processed milk as well. From Schamberger & Labuza:

This research studied the effectiveness of using EC and EGCG in a model system as well as in thermally processed milk. The addition of these extracts was found to reduce Maillard browning associated fluorescence and color change during UHT milk processing.

During storage EC and EGCG at a 1.0 mmol concentration reduced Maillard fluorescence to a negligible level in the glucose/glycine mixtures and milk samples. Maillard fluorescence was also reduced when these compounds were used at a level of 0.1 mmol in milk during storage. Consumer sensory testing analysis found the green tea milk samples were liked as well or better than the control milk samples. These results indicate that EC and EGCG have potential for use as Maillard browning inhibitors in food.

UHT processing of milk produces a lot of AGEs (significantly more so than ordinary milk). This study shows that adding green tea catechins to the milk reduced AGEs to negligible levels. The authors suggest that green tea might work similarly for other foods as well.

So what is the take home message from all this? The 300 mg/kg used in the first study is not directly translatable to humans; for an average male of 70 kg, that would be equal to 21 grams of extract. One green tea capsule meant for humans might have anywhere between 50 mg and 1 gram of extract, so matching the rats would mean taking at least 21 capsules.

The good news is that a lot of the other studies on green tea in humans show that much lower amounts are needed to get benefits. Anywhere between 2 and 10 cups of green tea per day is a reasonable amount, or if you want to take the supplement route, one to three capsules will usually equal the same amount (depending on how strong the extract is, of course).