

# Possible Modulation of Acrylamide Through Cooking Practices

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# Browning Foods Protects Health by Producing Beneficial Antioxidants

- Professor Shibamoto addressed the chemical formation of antioxidants during the Maillard browning reaction
- Antioxidants produced during the browning reaction are well known to be health protective concerning diseases associated with oxidative damage and stress:
  - Cancer
  - Atherosclerosis
  - Diabetes
  - Inflammation
  - Arthritis
  - Immune deficiency
  - Aging

# Antioxidant Effects of Maillard Reaction Products

- ◆ Many studies of model systems and foods have shown that Maillard Reaction Products (MRPs) have antioxidant effects. For example:
  - ◆ Wagner et al., Antioxidative potential of melanoidins isolated from roasted glucose-glycine model. *Food Chem.* 2002.
  - ◆ Antony et al., Antioxidative effect of Maillard reaction products added to turkey meat during heating by addition of honey. *J. Food Sci.* 2002.
  - ◆ Yanagimoto et al., Antioxidative activity of heterocyclic compounds found in coffee volatiles produced by Maillard reaction. *J. Agric. Food Chem.* 2002.
  - ◆ Steinhart et al., Antioxidative effect of coffee melanoidins. *Coll. Sci. Int. Cafe* 2001.
  - ◆ Monti et al., LC/MS analysis and antioxidative efficiency of Maillard reaction products from a lactose-lysine model system. *J. Agric. Food Chem.* 1999.
  - ◆ Yamaguchi, Antioxidative activity of aminocarbonyl reaction product. *Denpun Kagaku.* 1991.

# MRPs Are Shown to Provide Additional Health Benefits

- In addition to antioxidant effects, studies show that MRPs also provide other beneficial health effects:
  - Some MRPs have anti-carcinogenic effects
  - Some MRPs have anti-mutagenic effects
- Other MRP protective mechanisms include:
  - Induction of detoxification enzymes

# Anti-Carcinogenic Effects of MRPs

- Marko et al., Maillard reaction products modulating the growth of human tumor cells in vitro. *Chem. Res. Toxicol.* 2003.
- Marko et al., Studies on the inhibition of tumor cell growth and microtubule assembly by 3-hydroxy-4-[(E)-(2-furyl)methylidene]methyl-3-cyclopentene-1,2-dione, an intensively coloured Maillard reaction product. *Food Chem. Toxicol.* 2002.
- Kim et al., Effects of browning reaction products on DNA damage. *Saengyak Hakhoechi* 2000.
- Aeschbacher, H. U., Anticarcinogenic effect of browning reaction products. *Proc. Int. Symp. Maillard React.*, 4<sup>th</sup>. 1990.

# Anti-Mutagenic Effects of MRPs

- Lee et al., Biofunctional characteristics of the water soluble browning reaction products isolated from Korean red ginseng. Study on the antimutagenic and nitrite scavenging activities. *J. Ginseng Res.* 2001.
- Yen and Hsieh, Mechanisms of antimutagenic effect of Maillard reaction products prepared from xylose and lysine. *Royal Soc. Chem.* 1994.
- Jenq et al., Antimutagenicity of Maillard reaction products from amino acid/sugar model systems against 2-amino-3-methyl imidazo-[4,5-f]quinoline: the role of pyrazines. *Mutagenesis* 1994.
- Yen and Chau, Inhibition by xylose-lysine Maillard reaction products of the formation of MeIQx in a heated creatinine, glycine, and glucose model system. *Bios. Biot. Biochem.* 1993.

# MRPs Aid Detoxification By Enhancing Expression of GST Enzymes

- Many studies have established that glutathione-S-transferase (GST) is the primary detoxification enzyme for acrylamide
- A 2002 study by Hofmann's group in Germany showed that a browning reaction product, N<sup>ε</sup>-carboxymethyllysine (CML), enhances the expression of GST in rats and in Caco-2 intestinal cells
  - Experimental design:
    - Casein-linked CML was fed to rats for 10 days at two doses
    - CML also was given by supplementing the rats' diet with bread crust such that they received a moderate dose of CML
- Results:
  - Both animal experiments showed an inductive effect of casein-CML and of bread crust on GST activity in the kidneys
  - Cell culture results confirmed these inductive effects on GST
- Significance: while the browning reaction creates acrylamide, it also creates a beneficially protective chemical – CML – that results in increased detoxification of the acrylamide found in browned foods