

THE EFFECT OF SPICES ON THE REDUCTION OF THE FORMATION OF MUTAGENIC/CARCINOGENIC HETEROCYCLIC AMINES IN BEEF PATTIES

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Background:

Epidemiological studies have shown that the daily diet could be responsible for a lot of cancer. The possible relationship between meat intake and cancer incidence has especially led to a lot of investigations into the presence of mutagens and carcinogens in foods. The Heterocyclic Amines (HAs), present especially in the crust of fried meat and fish, are powerful mutagens. Several HAs have shown to be carcinogenic in long-term animal studies on rodents and non-human primates (ADAMSON et al., 1990). The International Agency on Cancer Research has classified several HAs as possible carcinogens and has recommended reducing human exposure to these compounds (IARC, 1993). The HAs are usually formed as products of the Maillard reaction. Creatine or creatinine and Maillard products from free amino acids and hexoses such as pyrazines, pyridines and aldehydes are assumed to form imidazo-quinolines, -quinoxaline (IQ-compounds) and -pyridines. The important influences on the formation of HAs appear to be the temperature and the heating time (ARVIDSSON et al., 1997). In addition the heat transfer to the surface of the product affect the formation. Many factors appear to influence this complex reaction. A lot of studies have reported the influence of antioxidants on the formation of HAs (JOHANSSON et al., 1996). Several spices have an antioxidant effect. The antioxidant principle is known to be mainly phenolic or sulphur compounds, for example, in thyme or garlic (MURKOVIC et al., 1998). These authors described the reduction of the HAs formation with the application of the spices rosemary, sage, thyme and garlic to the surface of heated beef.

Objectives:

The aim of this study was to examine the possibility of reducing the formation of HAs by using several spices in beef patties. This is based on the hypothesis that spices have antioxidant effects and can inhibit radical reactions which play an important role in the formation of HAs.

Materials and Methods:

Preparation of beef patties: Pure beef, roughly desinewed and defatted, was coarsely minced through a 3 mm plate. 1.2% salt and each spice in concentrations of 0.2, 1.1 and 2.0% were added to the minced beef separately. The control batch was prepared without spices. The mixture was mixed with the mixer. 80 g \pm 1 g of the material were formed into beef patties with a special mold for hamburgers. The following spices were used: garlic, onion, oregano (dried), pepper (dried), mustard, curry powder, thyme (dried) and sage (fresh).

Heat treatment: The patties were laid on aluminium foil which was coated with oil. The patties were baked to a core temperature of 85° C for 15 minutes with heat convection in a convection oven (Wiesheu Wiwa, Lenzkirchen, D) at a temperature of 230° C. Every 60 seconds they were treated with steam for 1 second. The core temperature and the surface temperature were monitored.

Statistical analysis: Variance analysis (Dunnett test) was done with the SAS programme module (SAS, 1994)

Determination of HAs: The method included the polar and apolar HAs. The method of HPLC analysis with some modifications was based on the method described by GROSS and GRÜTER (1992). The peaks of HAs, also Norharman and Harman, in samples were identified by comparing the retention times and UV-spectra with standards.

Results and Discussions:

The surface and the core temperatures during the frying time are shown in Fig. 1. The surface temperatures of beef patties varied moderately as a function of heating periods in the convection oven. At the constant oven temperature of 230° C, the surface temperature already reached 100° C after 1 minute, however after 13 minutes it reached 200° C. The core temperatures increased constantly to 85° C. The conditions of using heating times and oven temperature were recommended by the producer of the convection oven and gave an attractive colour and a pleasant juiciness to well-done patties.

HAs were found in all patties, but in very low concentrations. Especially MeIQx (2-amino-3,8-dimethylimidazo[4,5-f]quinoxaline), Norharman and Harman were found in nearly all patties (Fig. 2, Fig. 3 and Fig. 4). The addition of onions in the patties resulted in a significantly lower concentration of MeIQx ($p < 0.05$) (Fig. 2). The highest concentrations of onions had a good effect in reducing the MeIQx formation and the amount is by all means typical for patties. In the same way garlic reduced the concentration of MeIQx, but this effect was not significant. MURKOVIC et al. (1998) also reported a reduction of MeIQx by using garlic. Both garlic and onion have a lot of compounds with sulphhydryl groups. An influence of different organo sulphur compounds such as cysteine, acetylcysteine and glutathione on MeIQx formation in meat matrix based model systems was reported (SCHOCH et al., 1998). This study showed that these compounds have the effect of reducing MeIQx formation. All other spices had no significant effects on MeIQx formation ($p > 0.05$). These batches are comparable with the control batch.

The concentration of Norharman and Harman increased significantly ($p < 0.05$) with the addition of high amounts of thyme, oregano, curry, pepper and sage, but these amounts resulted over-spiced products (Fig. 3 and Fig. 4). The β -carbolines developed from the reaction of free tryptophan and aldehydes and the reaction is not dependent on creatin(in)e as a precursor. These compounds may, therefore, be present in heated foods of both animal and vegetable origin and the formation of Harman and Norharman increased when creatinine was added in excess to the model system (JÄGERSTAD et al., 1998). The β -carbolines are not mutagenic in the Ames test, but have been shown to be co-mutagenic (SUGIMURA et al., 1982).

Conclusions:

The results demonstrated that the addition of onion and garlic have the effect of reducing the formation of carcinogenic MeIQx. These spices, especially onion, are normally used in the added amount during the household preparation of beef patties.

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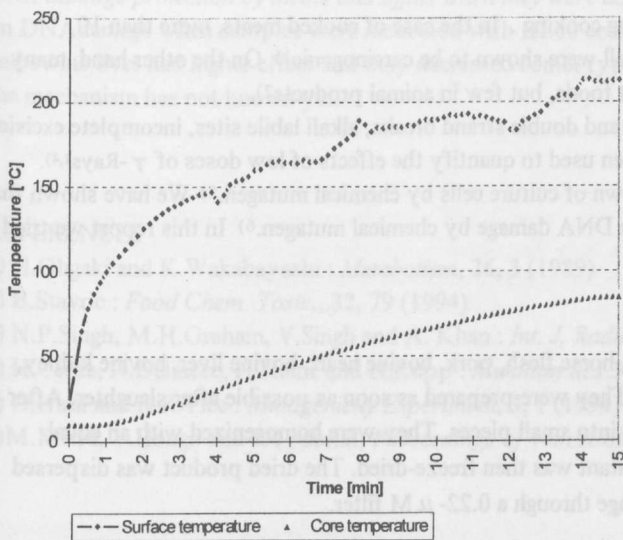


Fig. 1: Surface and core temperatures during the baking process

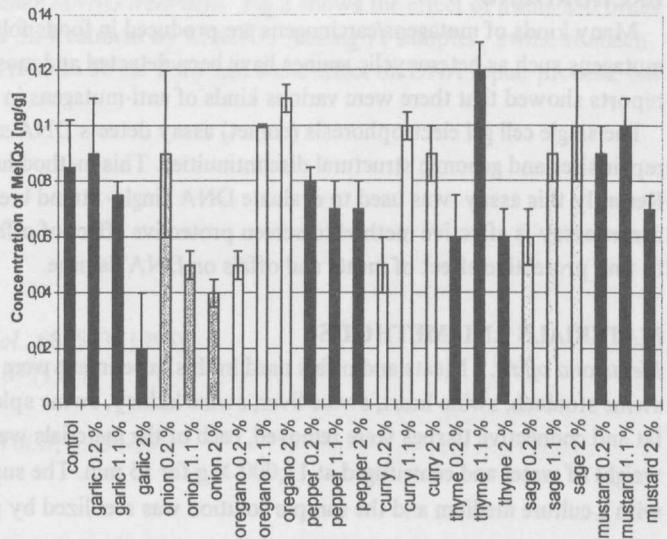


Fig. 2: Influence of spices on the concentration of MeIQx in beef patties

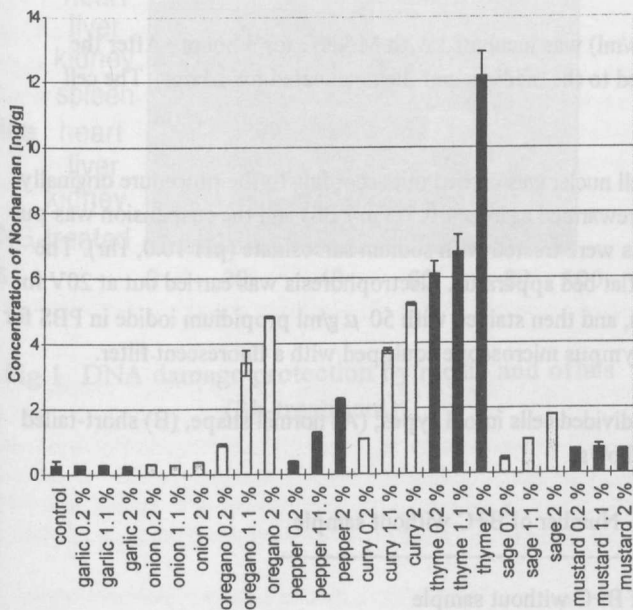


Fig. 3: Influence of spices on the concentration of Norharman in beef patties

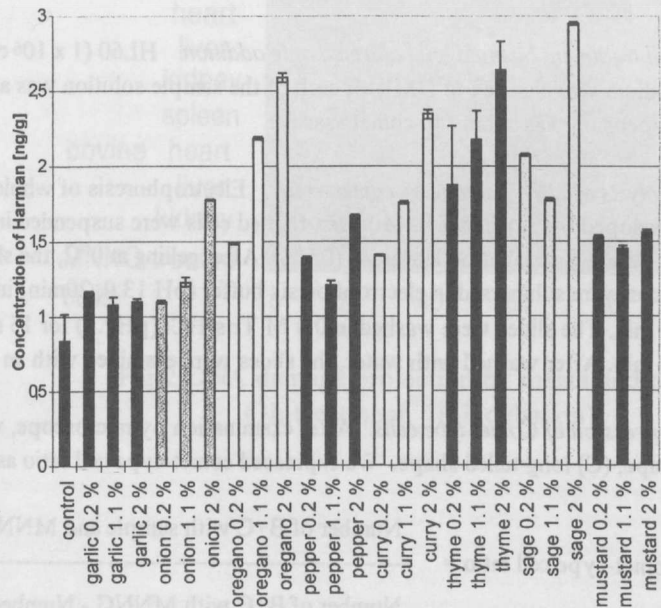


Fig. 4: Influence of spices on the concentration of Harman in beef patties

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