

INFLUENCE OF FRESH GARLIC AND SPICE EXTRACTS IN MARINADES ON THE FORMATION OF HETEROCYCLIC AROMATIC AMINES IN FRIED BEEF PATTIES

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Introduction

Epidemiological studies showed that the daily diet can be responsible for the initiation of different kinds of cancer. In the search for a possible relationship between diet and cancer, the highly mutagenic Heterocyclic Aromatic Amines (HAA), present in cooked food, were found by Japanese scientists nearly 30 years ago (Sugimura et al., 1977). These substances are found especially in the crust of fried, broiled and cooked meat and fish. The compounds were shown to be carcinogenic in long-term animal studies on rodents and monkeys (Adamson et al., 1990). The International Agency for Research on Cancer classified several HAA as possible (class 2B) or probable carcinogens (class 2A) and recommends a reduced dietary intake of these compounds (IARC, 1993). The major known HAA in fried meat products are MeIQx, 4,8-DiMeIQx and PhIP. These substances are responsible for most of the observed mutagenic activity in these foods and are usually formed as products of the Maillard reaction. The precursors are creatine or creatinine and Maillard products from free amino acids and hexoses. The important parameters of the HAA formation are the temperature and the heating time (Arvidsson et al., 1997), but the heat transfer to the surface of the product as well as the mass transport of the precursors outwards to the crust of meat also affect the formation of HAA. Some studies showed that the concentrations of HAA can be reduced by addition of compounds, which possess antioxidant potential (Murkovic et al., 1998). A number of spices are known for their antioxidant activity. Especially, the influence of fresh minced or crushed garlic and onion, as inhibitors on the formation of HAA, was reported (Murkovic et al., 1998, Gibis et al., 1999, Shin et al. 2002).

Objectives

The aim of this study was to examine the possibility of reducing the formation of HAA in beef patties by using several oil marinades with different concentrations of fresh garlic (*Allium sativum*), garlic extract or wood garlic extract (*Allium ursinum*). In addition, the beef patties should have an appetising colour and a non over spiced flavour.

Methodology

Material: Prepared deep frozen beef patties 70 g (Salomon Hitburger, Großostheim, Germany) (8 mm thick x 113 mm x 105 mm). The composition of the patties is shown in Table 1.

Specifications of extracts: (Raps, Kulmbach, Germany) 1. Wood garlic extract: wood garlic (*Allium ursinum*) 33 %, water, salt, stabilizer gum tragacanth (E 413), potassium sorbate (E 202), citric acid (E 330), modified corn starch.

2. Garlic extract: Garlic and salt, relationship extract to spice 1:3.

Heating devices: The two grill plates of a double contact grill (Nevada, Neumärker, Hemer, Germany) have a temperature of 230 °C. The deep frozen patties were coated with sunflower oil (refined) or different marinades (5g per side). The following concentrations of fresh minced and or crushed garlic, garlic or wood garlic extract were used (Table 2). The substances are added to 67.75 % sunflower oil (refined), 32 % water and 0.25 % emulsifier (mono- and diglycerides of fatty acids E 471, Gruenau, Illertissen, Germany). The patties were immediately fried on both sides simultaneously to a core temperature of 72 °C and a surface temperature < 190 °C at the end of the frying process. The beef patties were laid between tin foil and fried for 2:40 min.

Determination of HAA: The method included the 15 polar and apolar HAA. The method of HPLC analysis with some modifications was based on the method described by Gross and Grüter (1992). The peaks of HAA, as well as Norharman and Harman, in samples were identified by comparing the retention times and UV-spectra with standards.

Results & Discussion

Only MeIQx, PhIP and the β -carbolines Norharman and Harman were detected in all fried beef patties. The effect of the varying additions on the formation of HAA is demonstrated in the Figures 1, 2 and 3. Especially the content of the compound PhIP was significantly reduced by about 90 %, near the detection limit by using marinades with the addition of spice or extracts in the highest concentration. The first control batch fried with sunflower oil had the highest concentration of PhIP in comparison to the batches with spice addition. The second control batch fried with the emulsified marinade had similar concentrations of PhIP. Comparable to PhIP, the formation of the compound MeIQx was inhibited. The concentration of MeIQx in the fried beef patties was reduced by about 40 % through using fresh garlic and about 50 % by using garlic extract. Also the frying with the wood garlic marinades effected in a significant reduction of 50 % of the MeIQx content. The co-mutagenic Norharman and Harman were found in all beef patties, but the concentrations partly increased with higher addition of these extracts. These compounds do not possess any mutagenic activity as such, but become mutagenic together with non-mutagenic aromatic amines and can enhance the mutagenic potential of other HAA (Sugimura et al., 1982).

Fresh garlic has a number of compounds with sulphydryl groups, which were mainly formed by an enzymatic reaction after mincing. These substances showed a reducing effect on the formation of MeIQx and PhIP in other studies (Murkovic et al., 1998, Gibis et al., 1999, Shin et al. 2002). Likewise, garlic extract and wood garlic extract had the same reducing effect on the formation of HAA. The advantages of garlic extract consist in the better application and dosage in comparison to the fresh garlic. The inhibiting effect on the HAA formation is approximately the same between fresh garlic and extract, if the ratio (1:3) is considered in the specification of the producer.

An inhibiting effect of different organosulphur compounds such as cysteine, acetylcysteine and glutathione on MeIQx formation in meat matrix based model system was reported (Schoch et al., 1998).

The application of marinades has the advantage, that the beef patties have a pleasant flavour. The products are not over spiced. This marinating of meat is a traditional preparation before grilling in Mediterranean countries.

Conclusions

The application of garlic or garlic extract and wood garlic extract can inhibit the formation of HAA during the frying process. Especially, the concentration of PhIP in fried beef patties is nearly reduced up to the detection limit with the highest added concentration of spices or extracts.

References

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Abbreviations:

HAA: Heterocyclic Aromatic Amines,
 MeIQx: 2-amino-3,8-dimethylimidazo [4,5-*f*]quinoxaline,
 4,8-DiMeIQx: 2-amino-3,4,8-trimethylimidazo[4,5-*f*]quinoxaline,
 PhIP: 2-amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine
 Norharman: 9H-pyrido[3,4-*b*]indole
 Harman: 1-methyl-9H-pyrido[3,4-*b*]indole

Tables and Figures

Table 1. Composition of the frozen raw beef patties

Moisture	Mineral matter	Protein	Fat	Hydroxyproline	Creatine	Creatinine
[g/100g]	[g/100g]	[g/100g]	[g/100g]	[g/100g]	[g/100g dm]	[g/100g dm]
60.7	0.071	17.6	21.5	0.331	0.343	0.01

dm: dry matter

Table 2. Used concentrations of wood garlic extract, garlic extract and fresh minced garlic in oil marinades

Wood garlic extract [g/100 g marinade]	Garlic extract [g/100 g marinade]	Fresh garlic [g/100 g marinade]
1.5	0.15	0.5
3	0.3	1
4.5	0.6	3
6	1.2	6
	1.8	9
		12

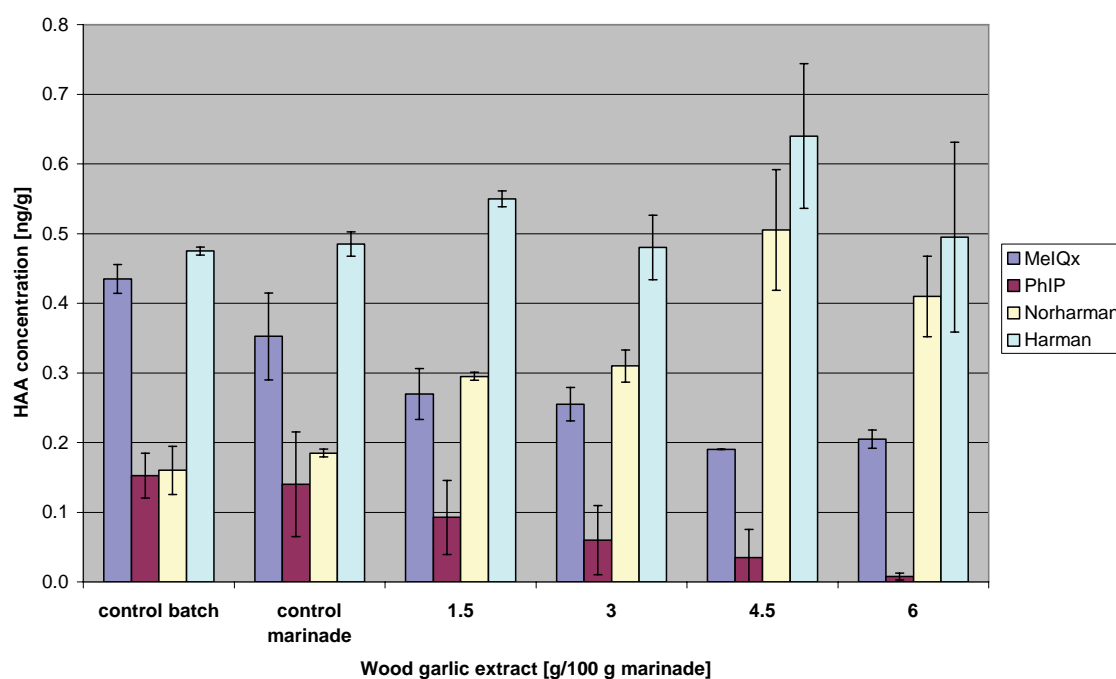


Figure 1: HAA concentrations of fried beef patties after application of marinades with wood garlic extract

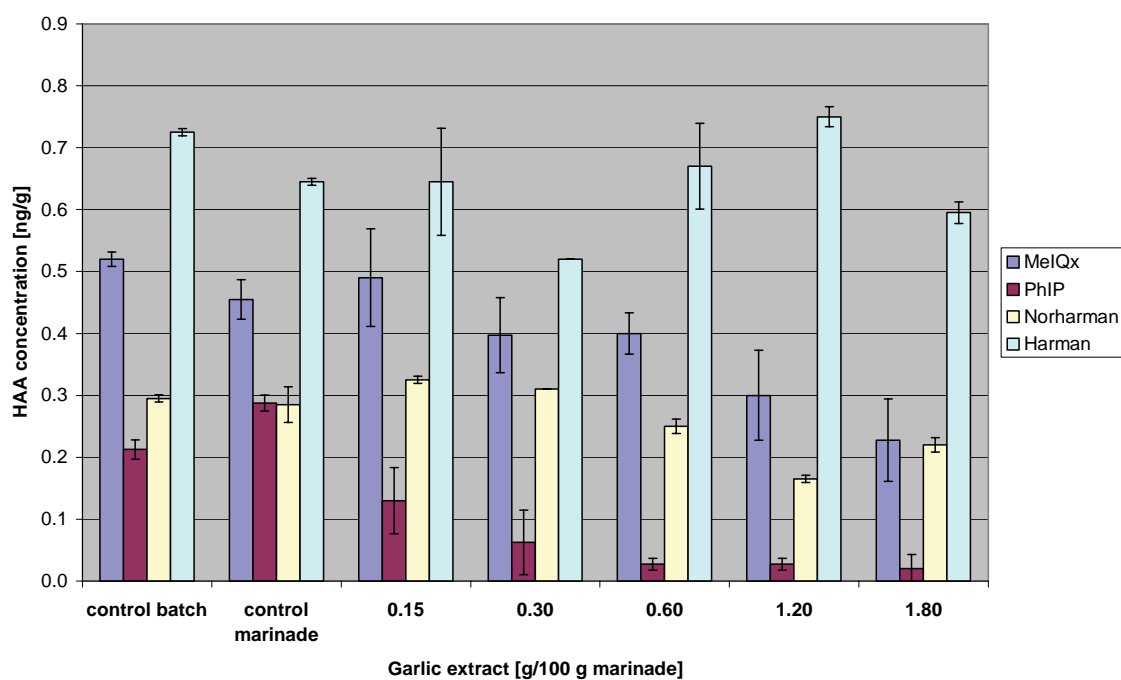


Figure 2: HAA concentrations of fried beef patties after application of marinades with garlic extract

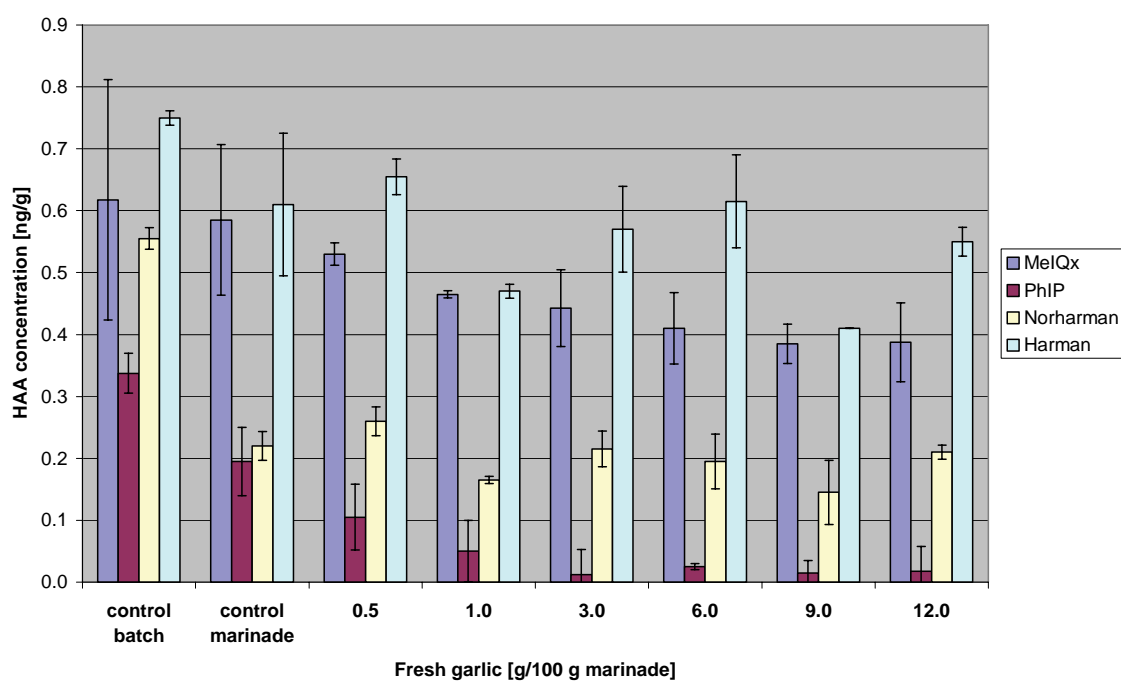


Figure 3: HAA concentrations of fried beef patties after application of marinades with fresh garlic