

INFLUENCE OF DIFFERENT DOUBLE SIDED CONTACT GRILLING EQUIPMENT ON HETEROCYCLIC AMINE CONTENT IN HAMBURGERS

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Background

The great variation in human diets and dietary content of food carcinogens may explain the observed variation in cancer rates world-wide. The Heterocyclic Amines (HAs) are especially found in the crust of fried, broiled and cooked meat and fish. These mutagens are probably formed from creatinine, aldehydes and Maillard reaction products such as pyrazines, pyridines and aldehydes. 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 human carcinogens and has recommended a reduction in exposure to these substances (IARC, 1993). The important influences on the formation of HAs are the temperature and the heating time (ARVIDSSON et al., 1997), but the preparation methods with the various forms of heat transfer to the surface of the product and mass transport of the precursors outwards to the crust of meat also affect the formation of HAs (GIBIS et al., 2000).

Objectives

The objective of this study was to examine the possibility of reducing the formation of HAs in beef patties by using the same preparation method but different contact grills with top and base hot plates. The beef patties were tested for weight loss, colour and creatine/creatinine content.

Methods

1. **Self-made hamburgers:** Preparation of beef patties: Beef, roughly desinewed and defatted, was coarsely minced through a 3 mm plate. 1.2 % salt were added to the minced beef separately. The mixture was mixed with the mixer. 80 g ± 1 g of the material were formed into beef patties with a special mould for hamburgers (16 mm thick x 85 mm diameter, 10 % fat).

2. Prepared deep frozen hamburgers 100 g (Salomon Hitburger, Großostheim, Germany) (9 mm thick x 120 mm diameter, 23 % fat)

Heating equipment: 1. Conventional double contact grill with top and base cast iron plates (Nevada, Neumärker, Hemer D).

2. Double contact grill with top and base composite plates Duranel® consisting of aluminium core and steel surface (S-tronic -162, Silex, Hamburg, Germany)

Heating devices: The two grill plates of both double contact grills have the temperature of 230°C. The patties were fried on both sides simultaneously to a core temperature of 75°C without tin foil and 72°C with tin foil. The cooking conditions are described in Table 1, which were determined in pre-experiments.

Table 1. Cooking parameters for the hamburgers

Material	Cooking time	
	Conventional double contact grill with cast iron plates	Double contact grill with Duranel® plates and the top plate with teflon foil
Prepared frozen hamburger 100 g without tin foil ²	4 min	2:10 min
Prepared frozen hamburger 100 g with tin foil ¹	4 min	2:10 min
Self-made hamburger 80 g without tin foil ²	5 min	2:30 min
Self-made hamburger 80 g with tin foil ¹	5 min	2:30 min

¹The beef patties were laid between tin foil which was coated with oil. ²The contact grill plates were coated with a little bit of oil.

Determination of weight loss during cooking: The patties were weighed before and 1 hour after heating.

Colour measurements of hamburgers: Patties were evaluated using a Chromameter CR 200 (Minolta, Osaka, Japan) 1 hour after heating.

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, as well as Norharman and Harman, in samples were identified by comparing the retention times and UV-spectra with standards.

Determination of creatine/creatinine: Creatine/creatinine were determined enzymatically according to the Boehringer test kit instruction (ANOMYM, 1989).

Results and discussion

In the following discussion, differences were investigated with regard to parameters such as cooking time, weight loss and HA content between the different double sided contact grills.

An important advantage of double sided contact grilling with the Duranel® plates was the low cooking times of hamburgers in comparison to the conventional contact grilling with cast iron plates. The time was reduced by nearly 50 % for both investigated hamburgers (Table 1). In addition, the double sided contact grilling with Duranel® plates resulted in a lower weight loss of the hamburgers (Figure 3). The L*-value of the colour measurements are shown in Figure 3. The L*-values of the surface of the self-made and purchased deep-frozen hamburgers after cooking were only slightly different with the both double contact grills. HAs were found in all patties, but in very different concentrations. A great difference was found in the concentrations of MeIQx, PhIP, 4,8-DiMeIQx, Norharman and Harman in the beef patties which were cooked with different contact grills. (Figure 1 and 2). The frying of the same hamburgers with the double sided contact grill with the Duranel® plates showed a reduction in the content of MeIQx, 4,8-DiMeIQx and PhIP of nearly 60 % on average in all investigated hamburgers. The same frying process using tin foil showed in addition to a reduction of the HA content for both contact grills that the core temperatures of frying with tin foil were a little bit lower. The creatine/creatinine content of the raw material based on the dry matter of the self-made hamburgers and the prepared deep frozen hamburgers clearly differentiated by about 30 % (Figure 4).

The study showed that the physical effect also plays an important role in the formation of the HAs. Several studies have also reported that the type of meat and doneness level, place of cooking (home or fast food restaurant) or cooking methods (pan-fry, grill/barbecue or oven broil) can play a major role in determining HA content (SKOG et al., 1997; SHINHA et al., 1998; GIBIS et al., 2000).

The heat and the transport of HAs precursors in meat during frying is very complex. The double sided contact grill with the Duranel® plates produce very little radiant heat, so that not much heat is absorbed by the surrounding environment. The stainless steel surfaces of the plates can reflect heat back into the aluminium core of the plates better than the cast iron plates of the conventional contact grill. The heat is

absorbed and given off when the plates touch the beef patties. Through the protein denaturation, the pores of the meat product are closed quickly before the meat juice moves outwards. The juice is important for the mass transport of the water-soluble precursors such as creatinine and Maillard reaction products to the crust and so for the formation of HAs. The preparation of hamburgers with the double sided contact grill with the Duranel® plates can reduce the cooking time and weight loss, and due to these parameters, the formation of MeIQx, PhIP, 4,8-DiMeIQx, Norharman and Harman.

Conclusions

This study shows that the use of a double sided contact grill with Duranel® plates resulted for the preparation of hamburgers at the same core temperatures of the patties in shorter cooking times and lower weight losses and therefore a reduction of the formation of Heterocyclic Amines in comparison to a conventional contact grill with cast iron plates.

Pertinent literature

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Abbreviations: HAs= Heterocyclic 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

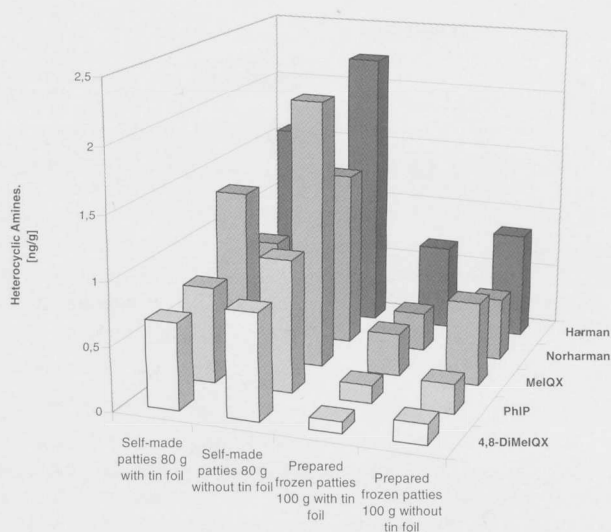


Fig. 1: Concentrations of HAs in hamburgers by using a conventional double sided contact grill

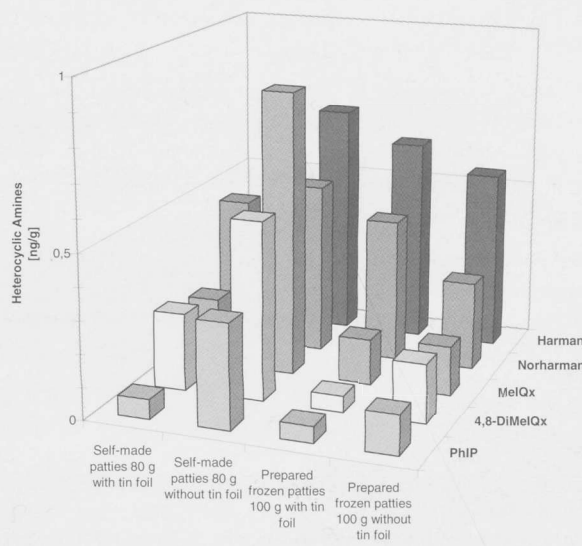


Fig. 2: Concentrations of HAs in hamburgers by using a double sided contact grill with Duranel® plates

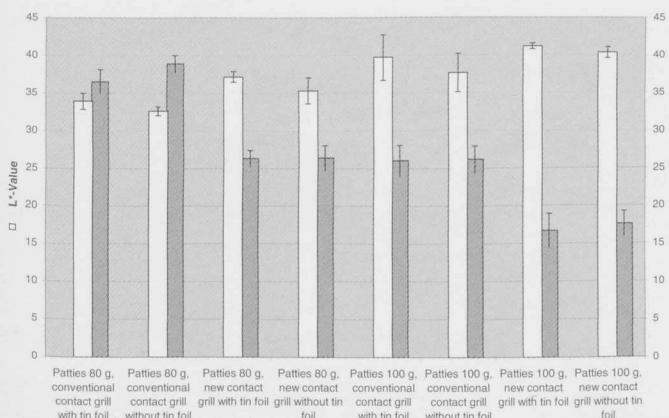


Fig. 3: L*-values and weight loss of hamburgers with different cooking parameters

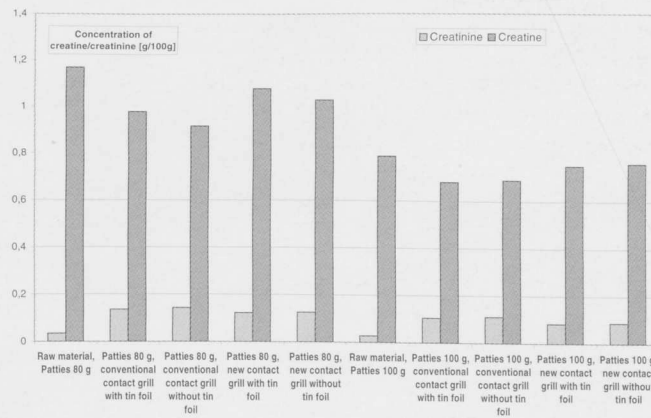


Fig. 4: Concentrations of creatine/creatinine based on the dry matter in hamburgers