EFFECT OF FRYING OIL ON THE FORMATION OF HETEROCYCLIC AMINE IN FRIED BEEF PATTIES

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Keywords: Heterocyclic Amines, frying oil, MeIQx, PhIP, DiMeIQx, carcinogen

Background

Several epidemiological studies have shown a relationship between the intake of fried, roasted or broiled meat and meat products and the incidence of cancer. The Heterocyclic Amines (HAs) are especially found in the crust of fried, broiled or cooked meat and fish. These substances are formed during the Maillard reaction from creatinine, carbohydrates and amino acids. Various HAs have shown to be carcinogenic in long-term animal studies on rodents and non-human primates (ADAMSON et al., 1990). The International Agency for Research on Cancer has classified several HAs as possible human carcinogens and gives the recommendation to reduce these compounds in exposure of humans (IARC, 1993). The important influences on the formation of HAs are physical parameters such as the temperature and the heating time (ARVIDSSON et al., 1997). But also substances with an antioxidant potential can inhibit the formation of HAs, because free radicals are involved in the complex Maillard reaction. A lot of edible oils contain antioxidants, for example tocopherols or phenolic compounds.

Objectives

The objective of this study was to examine the possibility of reducing the formation of HAs in beef patties by using different frying oils or fats. The beef patties were additionally tested for weight loss and colour.

Methods

Material: Prepared deep frozen beef patties 62.5 g (Salomon Hitburger, Großostheim, Germany) (6 mm thick x 100 mm diameter, 23 % fat)

Heating devices: The two grill plates of a double contact grills (Nevada, Neumärker, Hemer Germany) have the temperature of 230 °C. The deep frozen patties were coated with following different oils (5g per side): sunflower oil (refined), virgin olive oil, butter fat, safflower oil (refined) (low oleic acid oil), corn oil (refined) and coconut oil (refined). The patties were immediately fried on both sides simultaneously to a core temperature of 72 °C and to a surface temperature < 190 °C on the end of the frying process. The beef patties were laid between tin foil and were fried for 1:50 min.

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

Colour measurements of beef patties: Patties were measured the L*-values (brightness) 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.

Sensory test: 17 sensory testers evaluated the colour of the fried samples with a scale from 0 (too dark) to 10 (too bright).

Results and discussion

The polar and apolar HAs MeIQx, PhIP, Norharman and Harman were found in all beef patties. 4,8-DiMeIQx was only recovered in the patties which were fried with safflower oil. The concentrations of HAs in beef burgers fried in different frying fat are shown in Fig. 1 and 2. Generally the amounts of HAs were low in the investigated beef burgers. But a significant higher contents of MeIQx and PhIP were detected in beef patties fried in safflower oil. The colour of the beef patties looked normally brown and appetisingly. The L*-values (brightness) of the surface of purchased deep-frozen beef patties after frying were only slightly different for the used frying oils (Fig. 3). The lowest L*-values and the darkest surface colour in the sensory test were obtained for the butter fat. Likewise olive oil and sunflower oil had similar L*-value. But the differences between the surface colour or the L*-values of the beef patties fried in different oils were not significant. Likewise the weight loss during the frying process was not significantly different as well (Fig. 4).

Some frying oils such as sunflower oil, safflower oil and corn oil have a higher content of total tocopherols than the other oils and fats. Some authors described that a high content of tocopherols could explain the observed reduction in the content of MeIQx and 4,8-DiMeIQx (JOHANSSON et al., 1995). In our investigation, the concentrations of HAs were only significantly different in the beef burgers fried in safflower oil. It is often difficult to distinguish between the chemical and physical effects of oils on the formation of HAs during the frying process. The used safflower oil had a lower smoke point temperature during frying than the other fats and oils. The other oils in fresh condition could be used to higher frying temperature. The heat transfer from the plate to the surface of the beef patties is changed, if the frying oil is absent. This could be an explanation that the beef patties fried in safflower oil had a higher content of HAs.

Conclusions

This study shows that the frying of beef patties in different oils and fat resulted in very low differences in the concentration of HAs. Only the used safflower oil is unsuitable for the frying process, because the smoking point temperature of the oil is too low for frying. In the present study, the surface temperature of the beef patties was lower than 190 °C. If the fried beef patties looked appetisingly and were not overcooked we found very low concentrations of HAs prepared on a double contact grill. However household cooking equipment like a frying pan lacks thermostatically controlled frying surfaces and the temperature varies within a wide range. Only the colour of the beef patties can serve as indicator.

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

References

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Pertinent literature

ADAMSON, R. H., THORGEIRSSON, U. P., SYNDERWINE, E. G., THORGEIRSSON, S. S., REEVES, J., DALGARD, D. W., TAKAYAMA, S. and T. SUGIMURA (1990): Jpn. J. Cancer Res. 81, 10-14; ARVIDSSON, P., BOEKEL M.A.J.S. van, SKOG, K. and M. JÄGERSTAD (1997): J. Food Sci. 62, 911-916; IARC (1993): IARC Monographs on the evaluation of carcinogenic risks to humans. No.56. Pp. 165-242. International Agency for Research on Cancer;; GROSS, G.A. and A. GRÜTER (1992): J. Chromatogr. 592, 271-278; JOHANSSON, M.A.E., FREDHOLM, L., BJERNE, I. and JÄGERSTAD, M. (1995): Fd. Chem. Toxic. 33, 993-1004

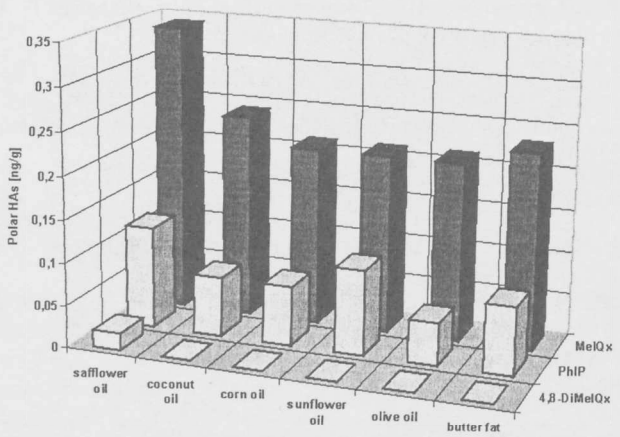

Fig. 1: Concentrations of polar HAs in beef patties fried in different fats and oils

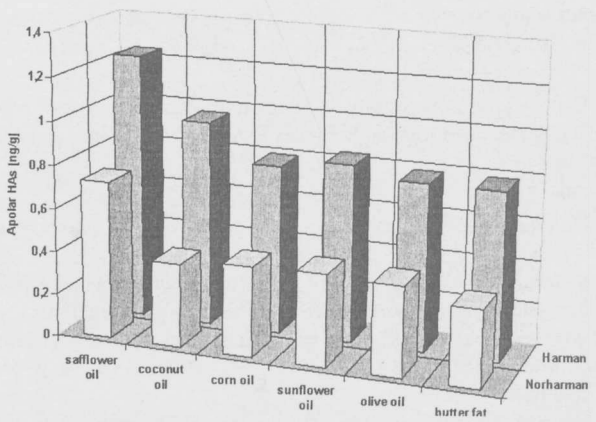

Fig. 2: Concentrations of apolar HAs in beef patties fried in different fats and oils

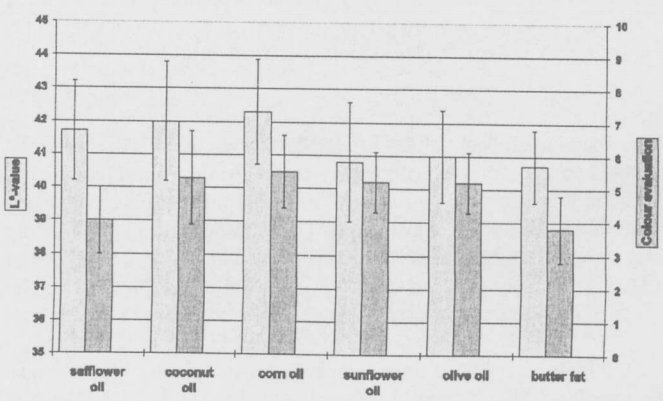

Fig. 3: L*-values and sensory colour evaluation (0 = too dark, 5= optimal, 10 = too bright)

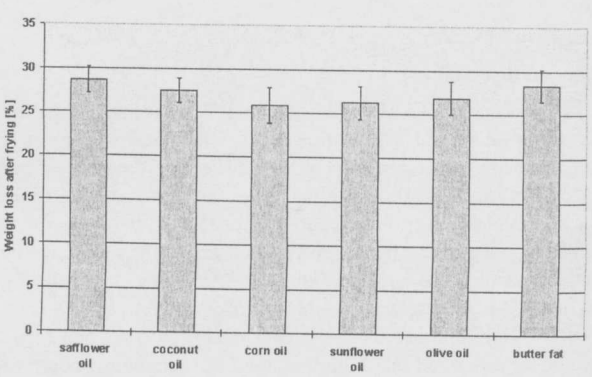

Fig. 4: Weight loss in beef patties fried in different fats and oils