

Inhibitory effect of lipophilic antioxidants in frying oil on formation of heterocyclic amines in fried patties

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Abstract

Heterocyclic Amines (HAs) are especially found in the crust of fried meat and fish. The major found mutagenic HAs in fried meat products are MeIQx and PhIP. The objective of this study was to examine the possibility of the inhibition on the formation in fried beef patties by using lipophilic antioxidants L-ascorbyl palmitate and α -tocopherol into frying oil. Only MeIQx, PhIP and the β -carboline Norharman and Harman were determined in all fried beef patties. Especially the content of PhIP was significantly reduced about 90 % ($p < 0.05$) by using sunflower oil with each addition of L-ascorbyl palmitate. Also the formation of the compound MeIQx and co-mutagenic Harman was significantly ($p < 0.05$) inhibited. The concentration of MeIQx and Harman in fried patties was reduced about 60 % in the batch frying with the highest concentration of L-ascorbyl palmitate in frying oil. The addition of α -tocopherol in frying oil showed no significant effect.

Introduction

Epidemiological studies showed that the daily diet can be responsible for different types of cancer. HAs are formed during the Maillard reaction from creatinine, carbohydrates and amino acids on the surface of cooked meat and fish. These compounds induce DNA damages and malignancy tumours in different organs of laboratory animals. The International Agency for Research on Cancer (IARC) classified several HAs as possible or probable carcinogens and recommends a reduced dietary intake to these compounds [1]. The major known HAs 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. The important effects of formation of HAs are the temperature and the heating time [2]. Some studies showed that the concentrations of HAs can be reduced by addition of compounds which possess antioxidant potential [3]. The objective of this study was to examine the possibility to reduce the formation of these substances in beef patties using the additive L-ascorbyl palmitate or α -tocopherol in frying oil. According to national regulation [4], the addition of L-ascorbyl palmitate or α -tocopherol is not defined with a limit in regard to frying oil.

Material and methods

Material and Preparing: 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 demonstrated in Table 1.

Table 1. Composition of the raw material (study 1 / 2: L-ascorbyl palmitate/ α -tocopherol)

Moisture	Mineral matter	Protein	Fat	Hydroxy proline	Creatine	Creatinine
[g/100g]	[g/100g]	[g/100g]	[g/100g]	[g/100g]	[g/100g dm]	[g/100g dm]
60.7 / 60.8	0.71 / 0.79	17.6 / 17.5	21.5 / 21.7	0.331 / 0.348	0.343 / 0.305	0.01 / 0.01

dm: dry matter

For each batch ($n=8$), patties were coated with a mixture of oil (5 g per side) composed of sun flower oil and several concentrations of L-ascorbyl palmitate or α -tocopherol (Sigma-Aldrich, St. Louis, MO, USA) (0.15 - 1.8 g/100 g oil). The patties were fried at preheated 230°C with a double contact grill (Neumärker, Hemer Germany). 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 2:30 min.

Determination of HAs: The method included 15 polar and apolar HAs. The method of HPLC analysis with some modifications was based on the method described by Gross and Grüter [5]. The peaks of HAs, as well as Norharman and Harman, were identified by comparing the retention times and UV-spectra with standards. The quantification was carried out with a standard addition or for Norharman and Harman with an external calibration.

Results and discussion

Only MeIQx, PhIP and the β -carbolines Norharman and Harman were detected in all fried beef patties. The effect of the different additions on formation of HAs is demonstrated in figure 1 and 2.

Especially the content of the compound PhIP was significantly reduced about 90 % ($p < 0.05$) nearly the detection limit by using sunflower oil with each addition of L-ascorbyl palmitate. The lowest concentration of the addition had the same effect on PhIP formation as the higher concentrations. Although as PhIP, the formation of the compound MeIQx and co-mutagenic Harman is significantly ($p < 0.05$) inhibited. The concentrations of MeIQx and Harman in the fried beef patties are reduced about 50 % in all batches which were fried with the addition of this antioxidant in sun flower oil. The concentration of the co-mutagenic Norharman was only reduced with addition of 1.2 g/100 g oil ($p < 0.05$). Norharman and Harman do not possess any mutagenic activity, but become mutagenic together with non-mutagenic aromatic amines and can enhance the mutagenic potential of other HA [6]. The addition of α -tocopherol in frying oil showed only a tendency of reduction in regard to the concentrations of PhIP and MeIQx. But the effects were not significant.

A lot of antioxidant substances showed a reducing effect on formation of MeIQx and PhIP in other studies [3, 7]. The reducing effect of virgin olive oil and rosemary extract on HA formation was reported, also the decrease of this effect during the storage [9]. In the sensory test, no difference could be determined between the fried control without any additions and samples with either L-ascorbyl palmitate or α -tocopherol in the frying oil. The addition of L-ascorbyl palmitate have the advantage that the fried beef patties got a typical pleasant colour and flavour without significant difference to the control.

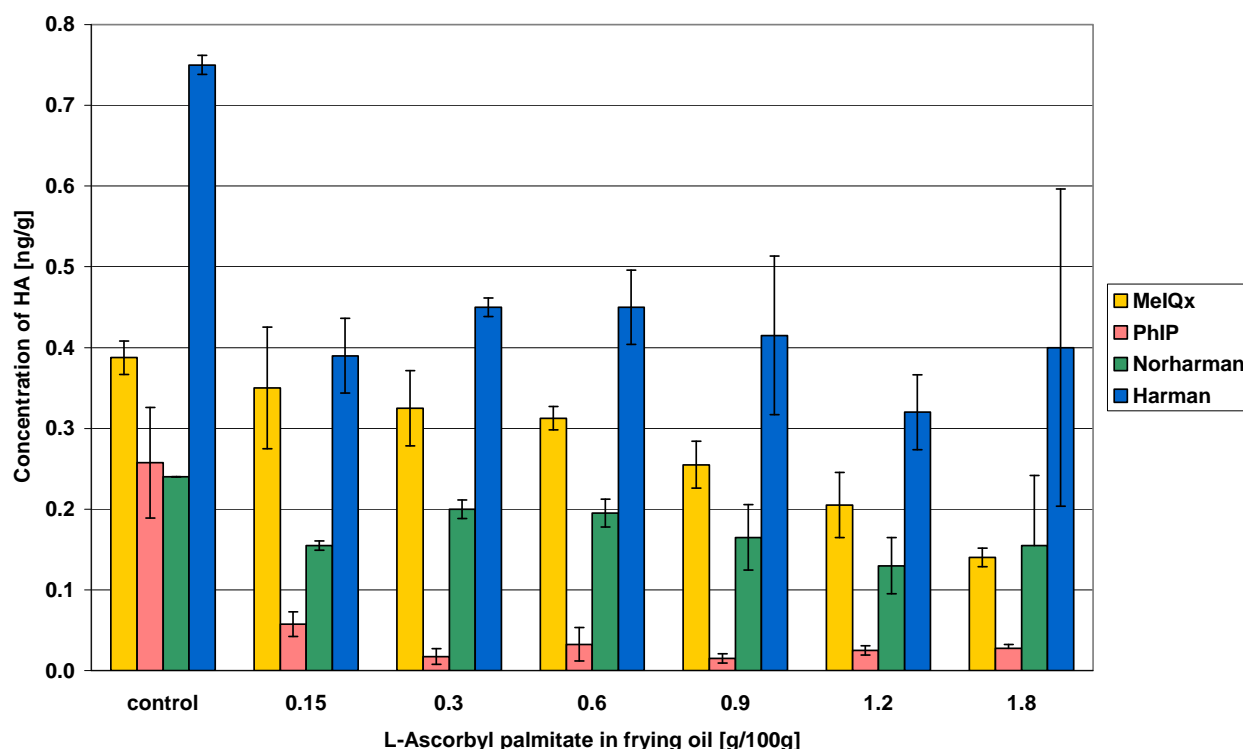


Figure 1. Concentration of HAs in beef patties fried with and without L-ascorbyl palmitate in oil.

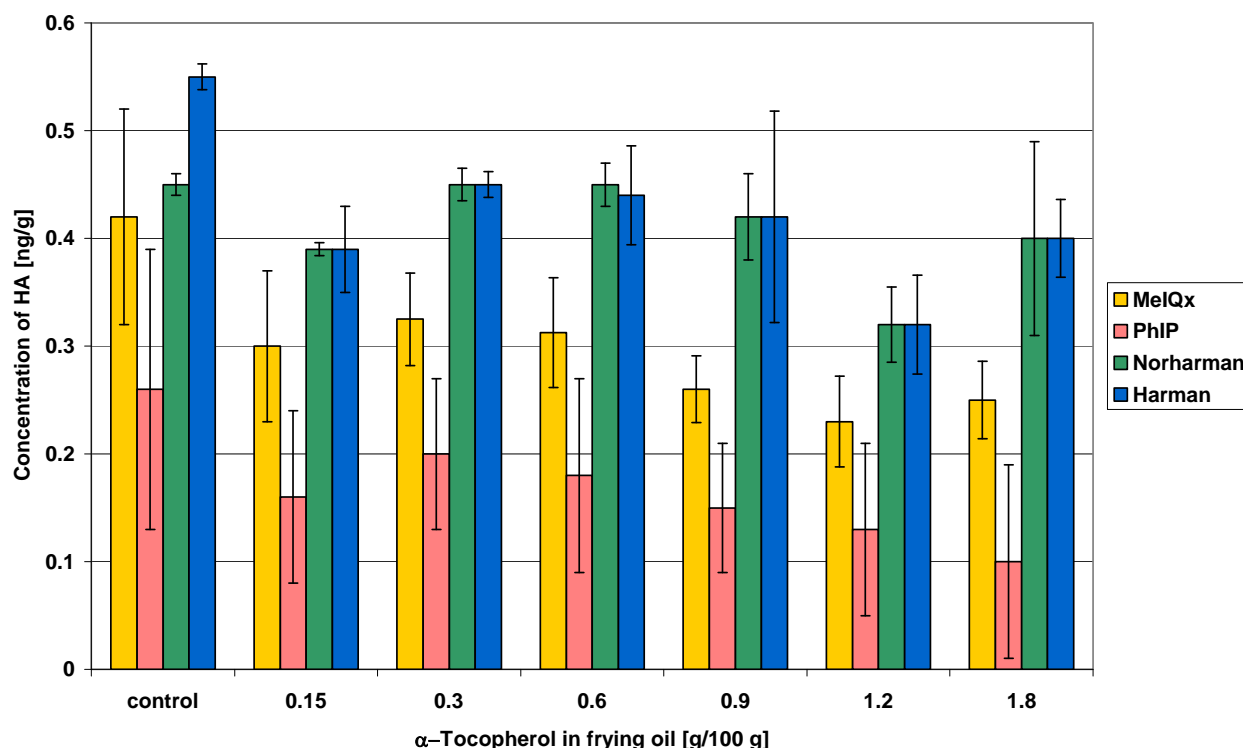


Figure 2. Concentration of HAs in beef patties fried with and without α -tocopherol in oil.

References

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Abbreviations

HA: Heterocyclic Amine,

MeIQx: 2-amino-3,8-dimethylimidazo[4,5-*f*]quinoxaline,

PhIP: 2-amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine