EFFECTS OF DIFFERENT ANTIOXIDANTS ON FORMATION OF MEAT MUTAGENS DURING FRYING OF GROUND BEEF

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SUMMARY

Meat mutagens are formed during frying of ground beef and are believed to develop through a free radical mechanism. Thus, we investigated the effects of adding some synthetic antioxidants (BHA, BHT, PG and TBHQ) on formation of some IQ-like mutagens (IQ, MeIQx and 4,8-DiMeIQx) during frying of ground beef. Although raw patties did not contain any detectable amount of mutagens, all cooked samples contained measurable quantities of IQ-like mutagens. However, added antioxidants inhibited mutagen formation except for BHT, which enhanced production of IQ-like compounds. Results demonstrated that addition of the synthetic antioxidants was effective in reducing the total quantity of meat mutagens formed during frying of ground beef, which supports the concept that the reactions involved in meat mutagen formation are indeed free radical driven. BHT, on the other hand, enhanced the total amount of meat mutagens, apparently by giving up a methyl group to form large quantities of 4,8-DiMeIQx.

INTRODUCTION

Miller (1985) has pointed out that mutagens formed during processing of muscle foods can be classified into two groups: (1) mutagens produced at high temperatures (>300°C), and (2) those formed at moderate temperatures (<300°C). The high temperature-induced mutagens are produced by pyrolysis of proteinaceous foods (Sugimura, et al., 1977) and are 2-amino-pyridine-type mutagens (Furihata and Matsushima, 1986). The moderate temperature-induced mutagens are 2-amino-imidazole-type mutagens (Furihata and Matsushima, 1986) and contribute most of the mutagenicity found in cooked meat (Kasai et al., 1979). Pearson et al. (1992) have proposed a free radical mechanism for formation of the meat mutagens.

OBJECTIVES

If the reactions involved are due to free radicals, antioxidants should inhibit the formation of IQ-like mutagens. Thus, this study was undertaken to determine if some synthetic antioxidants, namely, BHA, BHT, PG and TBHQ, would inhibit formation of meat mutagens during frying of ground beef.

MATERIALS AND METHODS

Ground beef patties containing 10% fat were prepared at 0.3 - 0.5 cm in thickness. The antioxidants were added to bring the concentration to 0.1% of the fat content of the meat. The patties were fried in an electric fry pan at a setting of 215°C for 9 minutes per side.

After frying, the patties were extracted and the IQ-like mutagens were quantified using modifications of the methods of Bjeldanes et al. (1982), Hayatsu et al. (1983) and Felton et al. (1984). Identification and quantification were carried out by HPLC (Model 600, Waters Associates, Milford, MA) using internal standards for IQ, MeIQx and 4,8-DiMeIQx. The quantities of the individual mutagens were added together to give a total for mutagenicity, although the mutagenic potency differs between compounds.

RESULTS AND DISCUSSION

Table 1 presents the results from this study comparing the effects of adding BHA, BHT, PG and TBHQ on the mutagens formed during frying of ground beef. The data demonstrate that the raw ground beef did not contain any detectable IQ-like compounds, although all samples contained appreciable amounts of mutagens following frying. BHA, PG and TBHQ all significantly decreased the concentration of IQ-like compounds formed during cooking, with the reduction in mutagen formation in comparison to the control amounting to about 56, 71 and 76%, respectively. On the other hand, BHT increased mutagen formation by 12% when added to the raw meat before cooking. Examination of the data showed that BHT enhanced total mutagen formation, with all of the increase in total mutagens being due to enhanced production of 4,8-DiMeIQx by about 8-fold over the fried control. The inhibitory effects of BHT are in agreement with Barnes et al. (1983) who found that BHA inhibited IQ formation by BHA of about 40% on frying of ground beef. This can be compared to inhibition of IQ formation by BHA of about 80% in the present study.

Figure 1 shows a plot of the same data in graph form and clearly demonstrates the inhibitory effects of BHA, PG and TBHQ on mutagen formation. The data also graphically show the increase in total mutagen formation for BHT is related to formation of large amounts of 4,8-DiMeIQx, whereas, BHT inhibited formation of IQ and MeIQx in comparison to the control.

It is clear from the data in Figure 1 and Table 1 that PG and TBHQ were both effective in reducing mutagen formation during frying of ground beef. In order to determine the effects of adding two different concentrations of TBHQ, we compared the effects of 0.02 and 0.1% on mutagen formation during frying of ground beef, which is shown in Figure 2.

Figure 1. Effects of Some Synthetic Antioxidants on Formation of IQ-like Mutagens

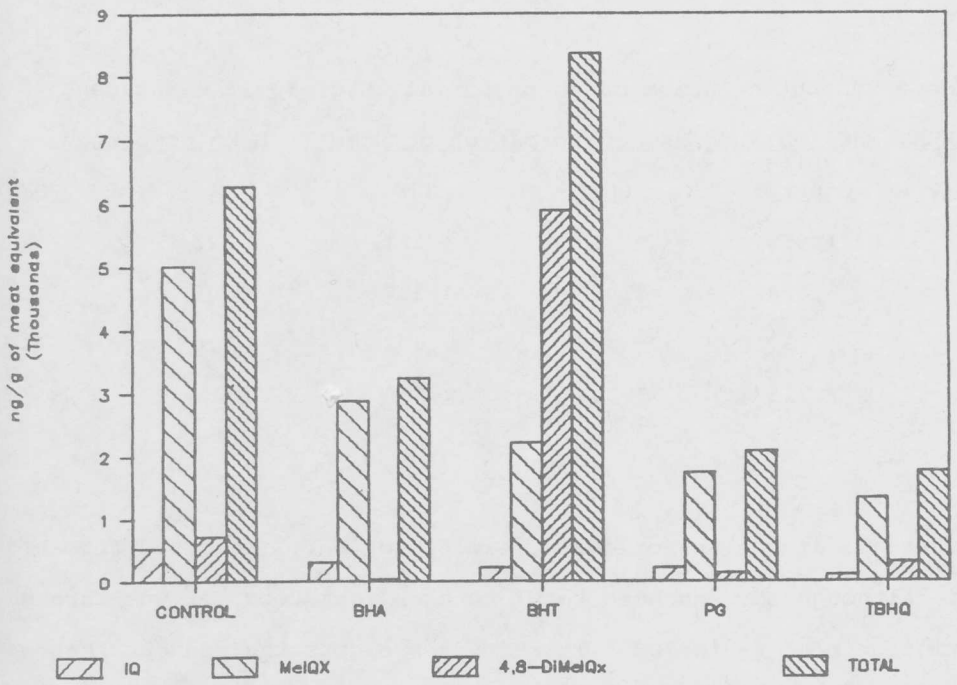
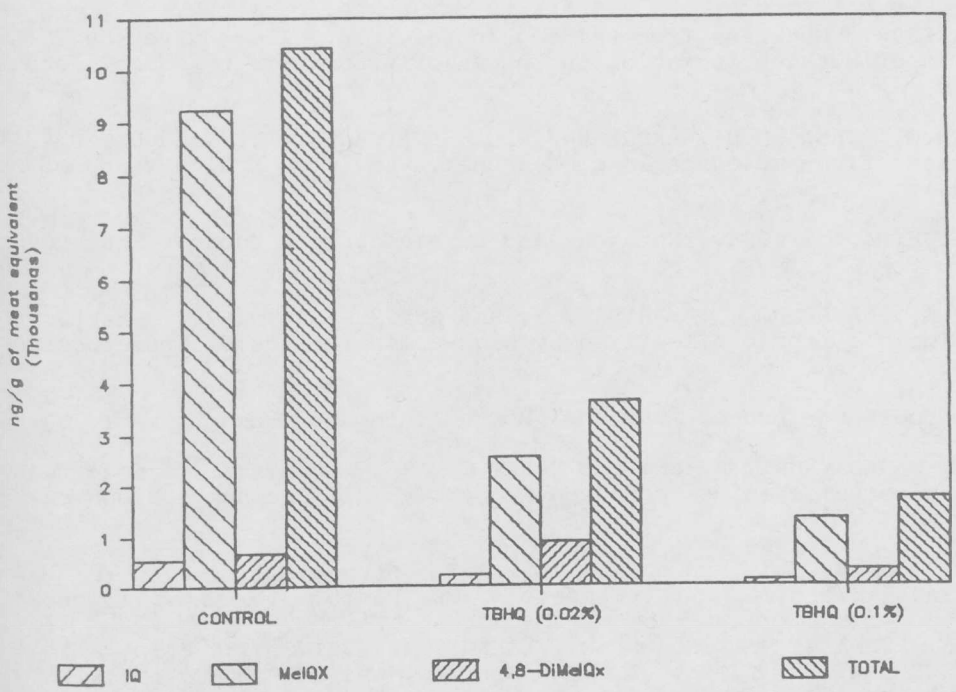


Figure 2. Relationship Between Two Levels of TBHQ.



Although both concentrations of TBHQ were effective in decreasing mutagen formation, the higher level was somewhat more effective than the lower one.

Figure 1. Effects of Some Synthetic Antioxidants on Formation of IQ-like Mutagens

TABLE 1. Effects of BHA, BHT, PG and TBHQ on Formation of Some IQ-Like Compounds

Mutagens	Raw Sample	Fried Control	BHA	BHT	PG	TBHQ
IQ	0	1,558	313	221	225	106
MeIQx	0	5,028	2,893	2,237	1,738	1,332
4,8DiMeIQx	0	730	38	5,902	136	321
Total	0	7,316	3,244	8,360	2,099	1,759

CONCLUSIONS

Results demonstrated that all of the antioxidants, except for BHT, inhibited formation of the IQ-like compounds. Although BHT enhanced total mutagen formation, it was through greatly increasing formation of 4,8-DiMeIQX. This study supports the concept that mutagen formation during frying of ground beef is through a free radical mechanism.

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