

## ANTIOXIDANTS MAY REDUCE HETEROCYCLIC AMINES IN COMMERCIALLY MARINATED BEEF STEAKS

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### Introduction

Heterocyclic amines (HCAs) are carcinogenic and mutagenic compounds found at a level of parts per billion in grilled fish and meats. Since the connection between consumption of dietary carcinogens and risk of different cancers in humans has been established, it is necessary to explore effective inhibitors that can prevent or reduce the formation of HCAs in cooked meats. Cooking meat with natural antioxidants decreases or eliminates HCAs in meat. Our objective was to study the inhibition of five HCAs in beef steaks marinated using commercial ingredients that are natural antioxidants.

### Experimental Procedures

Three marinades were used. Marinade 1 contained rosemary, thyme, and chives as the main antioxidant-containing spices. Marinade 2 contained oregano, thyme, garlic, and onion. Marinade 3 contained garlic and onion. Fresh eye of round steaks were marinated with each of the marinades for one hour, then grilled at 400°F for five minutes on each side. Control steaks were simply those without any marination and blank steaks were marinated with a commercial product containing vegetable oil, vinegar, and water.

Since HCA formation is a surface phenomenon, only the browned exterior surface was trimmed from grilled steaks for analysis. Samples were ground, then homogenized in

sodium hydroxide. Adsorbed polar and non-polar amines were eluted using methanol concentrated, ammonium-hydroxide solution, concentrated under nitrogen, and then dissolved in methanol. The amount of five known HCAs (MeIQ, MeIQx, harman, norharman, and PhIP) were measured by solid-phase extraction followed by high performance liquid chromatography (HPLC). The antioxidant level of each marinade was evaluated using ethanol and a water bath extraction method followed by HPLC.

### Results and Discussion

The levels of three potent antioxidants (rosmarinic acid, carnosol, and carnosic acid) found in each of the marinades are shown in Figure 1. Compared with controls, HCAs decreased by greater than 87% ( $P < 0.05$ ) in marinated steak samples (Figure 2). Marinade 1, which had the highest reduction effects on HCA formation, contained the highest amount of rosmarinic acid, carnosol and carnosic acid compare to marinades 2 and 3.

### Implications

Treatment of steaks with marinades containing antioxidants one hour before grilling resulted in a significant reduction of HCA formation. Using antioxidants rich in phenolic compounds, such as rosmarinic acid, carnosol and carnosic acid, present in commercial marinades, is suggested as a useful approach for HCA inhibition.

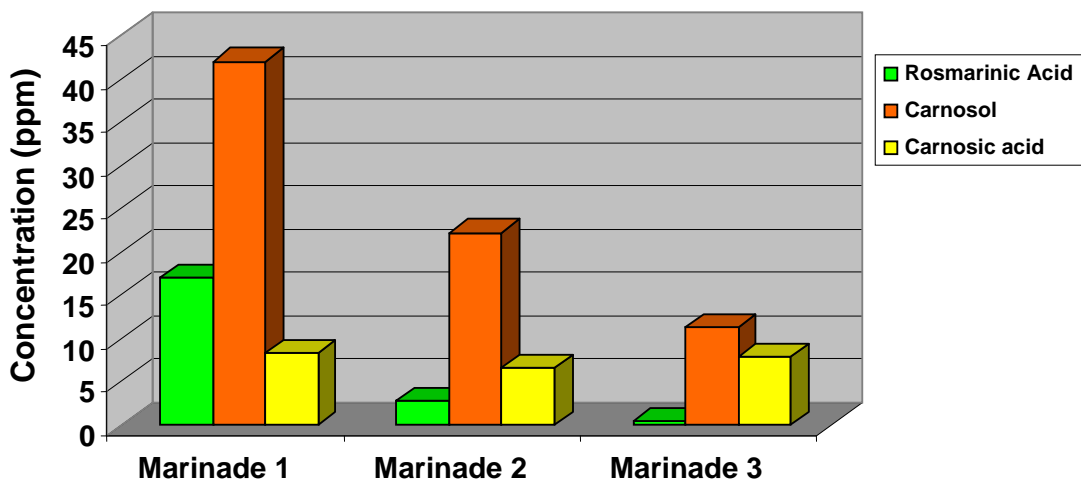


Figure 1. Level of Antioxidants in Different Marinades.

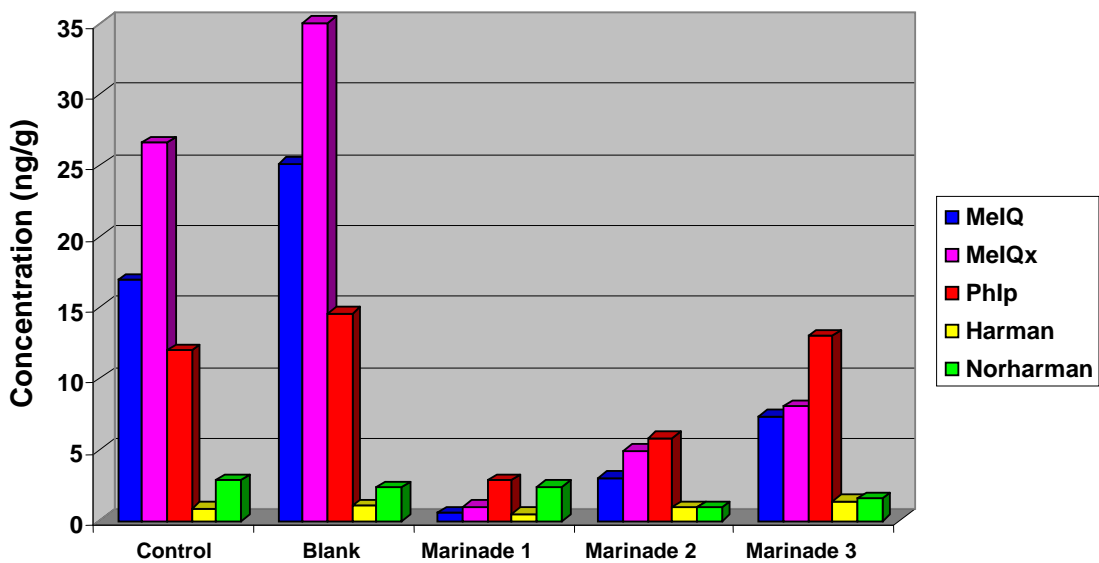


Figure 2. Level of HCAs in Control and Marinated Steaks.