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Phenolic compounds in beer inhibit formation of polycyclic aromatic hydrocarbons from charcoal-grilled chicken wings (#605)

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Introduction

Polycyclic aromatic hydrocarbons (PAHs) are produced from the partial combustion of fossil fuels and organic materials. The International Agency for Research on Cancer (IARC) have stated that PAHs contribute to carcinogenicity and mutagenicity in human health. For non-smokers and non-occupationally exposed consumers, the main route of PAH intake is from food. Many researchers have speculated that PAHs are formed through free radical reactions. Due to the unique flavor and taste of grilled meat products, it is a favored cooking method by many consumers. Taking into account the high levels of PAHs and risks to human health, precautions need to be implemented to inhibit the formation of PAHs from grilled meats. Marination, a widely used pre-cooking method for improving the flavor and taste of food in numerous cuisines, reduces the generation of these harmful substances. Beer has been reported to contain a complex mixture of phenolic compounds, so this study aims to survey the effects of beers on the formation of PAHs from charcoal-grilled chicken wings (CWs).

Methods

Marinating and grilling conditions. CWs were marinated for 4 h at 4 °C and the ratio of marinade to CWs was 1:1 (w/v, g/mL). After marinating, the samples were removed from the marinades and dried slightly. The marinades were collected and the DPPH free radical scavenging activity were determined. A garden-type gridiron was used to grill CWs. After the open flame was extinguished and hot coals remained, all samples were grilled on a shelf for 8 min. The samples were turned over every 2 min. After grilling, the CWs were deboned and homogenized with a mincer. The samples were then freeze-dried and stored at -80 °C until PAHs analysis.

Detection of DPPH scavenging activity. Briefly, 200 μ L of diluted sample (1:10) of marinades before and after marinating was added to a tube containing an equal volume of DPPH (0.2 mM, dissolved in 95% ethanol). Equal volumes (200 μ L each) of DPPH and distilled water (A_{blank}), and DPPH and 95% ethanol (A_{control}), were prepared as the blank and control, respectively. The absorbance at 517 nm was recorded after samples were reacted for 30 min in the dark. The scavenging activity was calculated using the formula: DPPH scavenging activity (%) = $[1 - (A_{\text{sample}} - A_{\text{blank}}) / (A_{\text{control}} - A_{\text{blank}})] \times 100$, with the results expressed as a percentage.

Analysis of PAHs. 3 g of sample was weighed and transferred to a tube containing 20 mL of acetonitrile and 10 mL of *n*-hexane saturated with

acetonitrile. Samples were vortexed for 30 s followed by ultrasound-assisted extraction for 30 min at 40 °C, then centrifuged at 4500 r/min for 5 min. The sublayer was transferred to a flask and residual solution was extracted again, extract solutions were evaporated to dryness. The residue was redissolved in 6 mL *n*-hexane and subjected to an activated silica cartridge. The cartridge was eluted with 25 mL dichloromethane/*n*-hexane (30:70, v/v). All eluents were evaporated to dryness under a nitrogen flow. The residue was redissolved in methanol/acetonitrile (1:9) and filtered through a 0.45 μ m membrane prior to analysis. The gradient system of water (A) and acetonitrile (B) was run at a rate of 0.64 mL/min. The linear gradient was started with 50% B for 2 min, then ramped to 100% B within 6 min and maintained for 3.2 min. Finally, B was decreased to 50% within 1 min and maintained for 2.8 min. The excitation and emission wavelengths were 290 and 410 nm for BkF, BaP, DbA and BgP; 260 and 430 nm for BbF; 270 and 390 nm for BaA and Ch; and 293 and 498 nm for IP.

Results

As can be seen from Figure 1, all beer marinades displayed activity in scavenging DPPH radicals. Before marinating, percent inhibition activity from Heineken (27.0%), Tsing Tao (23.6%), Budweiser (21.9%), Corona (21.4%), Harbin (9.5%), and Snow (8.1%) were determined. After 4 h marinating, a decrease in DPPH scavenging activity of all beer marinades was detected. The various profiles of PAHs content from CWs marinated with various marinades were assessed and shown in Table 1. The total content of PAHs in the control samples was 13.03 ng/g. Beer marinades exhibit different effects on PAHs generation. Among them, Heineken (4.31 ng/g) and Tsing Tao (8.89 ng/g) notably inhibit PAHs generation; Budweiser (12.55 ng/g) and Corona (12.76 ng/g) were very similar to the control; and Harbin (17.61 ng/g) and Snow (18.09 ng/g) show a negative effect compared to the control. Although the marinade inhibits the formation of PAHs in general, not each individual PAH was influenced.

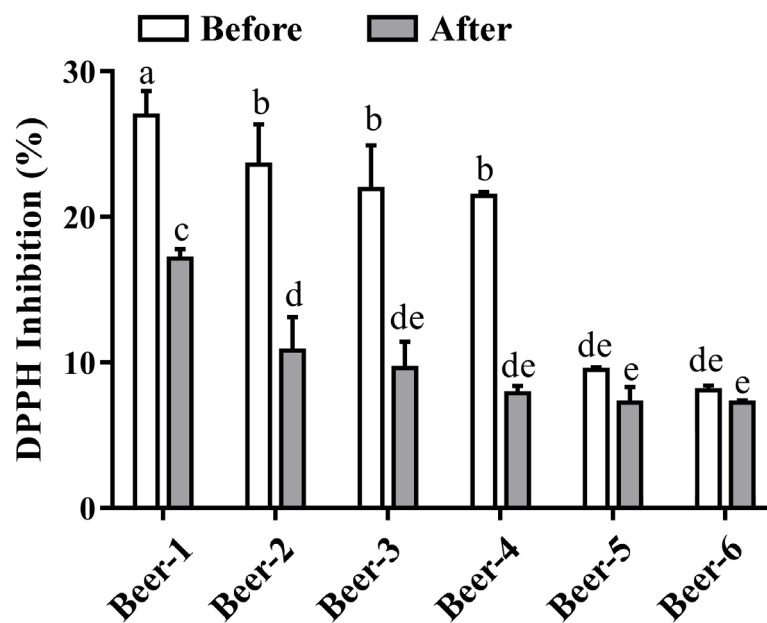
Conclusion

In this study, we investigated the DPPH scavenging activity of different beers and their effect on the formation of PAHs. It was found that the greater the DPPH scavenging activity, and the lower the PAH content. Among the beers studied, Heineken showed the strongest inhibitory effect on PAHs. We believed that the antioxidants in beer may serve as inhibitors of PAH generation by acting as radical quenchers and scavengers.

Notes

PAHs	PAHs (ng/g wet weight grilled meat)						
	Control	Beer-1	Beer-2	Beer-3	Beer-4	Beer-5	Beer-6
BaA	3.49 ± 0.62 ^b	1.47 ± 0.58 ^d	2.28 ± 0.56 ^{cd}	3.14 ± 0.50 ^{bc}	3.31 ± 0.29 ^b	5.73 ± 0.94 ^a	5.18 ± 0.74 ^a
Ch	1.62 ± 0.51 ^b	0.57 ± 0.23 ^d	0.92 ± 0.22 ^{cd}	1.26 ± 0.15 ^{bc}	2.07 ± 0.08 ^a	2.30 ± 0.26 ^a	2.11 ± 0.21 ^a
BbF	3.11 ± 0.63 ^{cd}	1.46 ± 0.35 ^e	2.84 ± 0.34 ^d	3.70 ± 0.39 ^{bc}	3.17 ± 0.12 ^{cd}	4.22 ± 0.44 ^a	4.89 ± 0.12 ^a
BkF	0.51 ± 0.20 ^a	ND	0.21 ± 0.04 ^a	0.33 ± 0.05 ^b	0.38 ± 0.01 ^{ab}	0.37 ± 0.06 ^{ab}	0.41 ± 0.03 ^{ab}
BaP	2.25 ± 0.46 ^{bc}	0.51 ± 0.27 ^e	1.47 ± 0.11 ^d	1.98 ± 0.25 ^c	2.27 ± 0.10 ^{bc}	2.63 ± 0.36 ^{ab}	2.81 ± 0.09 ^a
DbA	ND	ND	ND	ND	ND	ND	ND
BgP	2.05 ± 0.39 ^b	0.30 ± 0.14 ^e	1.17 ± 0.23 ^d	2.14 ± 0.24 ^b	1.56 ± 0.06 ^c	2.36 ± 0.27 ^b	2.69 ± 0.15 ^a
IP	ND	ND	ND	ND	ND	ND	ND
ΣPAH8	13.03	4.31	8.89	12.55	12.76	17.61	18.09

PAHs formation on charcoal-grilled CWs marinated with different marinades



The DPPH scavenging activity of beers before (Before) and after (After) marinating

Notes