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Effects Of Cooking On Free Amino Acids And Major Metabolites Changes In Beef Of Different Shear Forces By HR-MAS NMR (#490)

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Introduction

Several studies about chemical composition of beef, especially on the content of free amino acids, peptides and other nitrogen compounds that are responsible for sensorial characteristics were reported. The cooking process can change these metabolites, transforming in new compounds that can significantly affect the flavour and beef quality. In this context, NMR was used to study the chemical composition of raw and cooked beef, assigned in two groups by shear forces values, looking for chemical markers to identify changes that occur during cooking and differences on tenderness.

Methods

Longissimus dorsi steaks were taken from 28 non-castrated bulls after slaughter and 24 h chilling. The samples were individually vacuum packed and frozen stored. To Warner-Bratzler shear force (WBSF) analysis, samples were thawed at 5°C for 24 h. Steaks were cooked using an electric oven with top and bottom electrical resistances. Temperature was adjusted to 170°C (pre-heated) and the steaks internal temperatures were monitored with individual probes until they reached 71°C. Grilled steaks were packed into plastic bags and chilled at 7°C overnight. Six 1.27 cm cores per steak were taken in order to measure the WBSF using the Warner-Bratzler Meat Shear. Two groups were assigned according to the median value of the WBSF results: beef with WBSF lower than 8.86 Kg (A group, n = 14) and beef with WBSF higher than 8.86 Kg (B group, n = 14). To correlate the chemical profile of the beef according its WBSF, the samples were analyzed both raw and cooked. The NMR analyzes of the beef were performed in a Bruker Avance III 500 spectrometer equipped with a HR-MAS probe, avoiding the manipulation of the beef to preserve all the chemical information of the samples. The samples were homogenized in a sample preparer (FastPrep - 24) and packed in a 50 µL rotor, using 15.0 mg of sample and 37.0 µL of a stock solution of D_2O with 1% DSS and 2% of sodium azide. The measurements were done in duplicate, using rotor spinning rate of 5.0 kHz at 28 °C. Data were analyzed using Statistica software. In detail, the factorial ANOVA was performed to investigate the main differences between groups and cooking process (raw and cooked) as well as on the concentration of free amino acids, histidine compounds and other metabolites. Mean values were subsequently separated through the parametric Tukey HSD test. All statistical differences were considered significant at a level of $p<0.05$.

Results

The results of main metabolites identified of raw and cooked beef are shown in Table 1. The concentration of alanine and isoleucine increased after cooked in both A and B groups. IMP, fumarate and hypoxanthine metabolites, as well as inosine and acetate, were reduced after cooked in both A and B groups. When comparing groups according WBSF, concentrations of alanine, valine and isoleucine were higher on group of lower WBSF (A group). Also carnosine concentration was higher on A group, but only on cooked beef. For energy metabolism compounds, only lactate concentration was significantly different, which was higher on A group.

Table 1. Quantification of the identified compounds ± SD in raw and cooked beef (mg/100g of beef).

	A group (lower WBSF)		B group (higher WBSF)	
	Raw	Cooked	Raw	Cooked
Free amino acids				
Glutamine	197 ± 7	212 ± 10	206 ± 6	195 ± 7
Methionine	83 ± 4^{B}	76 ± 2^{A}	96 ± 5^{aA}	66 ± 2^{bB}
Alanine	103 ± 5^{b}	188 ± 8^{aA}	96 ± 3^{b}	159 ± 7^{aB}
Valine	110 ± 4^{A}	104 ± 6^{A}	92 ± 4^{B}	86 ± 3^{B}
Isoleucine	105 ± 5^{A}	126 ± 9^{A}	75 ± 3^{bB}	102 ± 5^{aB}
Histidinic compounds				
Carnosine	1150 ± 19	1200 ± 22^{A}	1171 ± 20^{a}	1112 ± 18^{bB}
Metabolites - energy metabolism				
IMP	143 ± 6^{a}	117 ± 8^{b}	149 ± 7^{a}	128 ± 6^{b}
Creatine	1115 ± 31	1169 ± 18	1080 ± 15	1107 ± 26
Lactate	2001 ± 48^{bA}	2497 ± 99^{aA}	1878 ± 35^{bB}	2111 ± 56^{aB}
Fumarate	12.1 ± 0.9^{a}	1.0 ± 0.4^{b}	12.0 ± 0.8^{a}	1.7 ± 0.7^{b}
Hypoxanthine	60 ± 1^{a}	51 ± 2^{b}	59 ± 1^{a}	47 ± 1^{b}
Other compounds				
Inosine	89 ± 2^{a}	65 ± 2^{b}	83 ± 3^{a}	62 ± 2^{b}
Acetate	21.8 ± 0.7^{a}	19.3 ± 0.6^{bA}	20.4 ± 0.7^{a}	17.6 ± 0.5^{bB}

Notes

SD: standard deviation; [a,b] Means comparing raw and cooked beef into the same group with different letters are significantly different ($p<0.05$); [A,B] Means comparing groups A and B into the same condition (raw or cooked) with different letters are significantly different ($p<0.05$).

Conclusion

The HR-MAS NMR technique was efficient on quantifying compounds from raw and cooked beef. Cooking process change concentrations of many compounds presents on beef. Free amino acids concentrations, like alanine, valine and isoleucine can be used as indicators of beef tenderness.

Notes