# PRESENCE OF OFF-FLAVOR IN RAW BEEF FROM DIFFERENT GEOGRAPHYCAL ORIGIN

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**Abstract – The aim of this study was to evaluate the presence of off-flavor in beef produced in different locations. An olfactometry analysis (GC-O) was carried out to select the compounds responsible for off-flavor to further identify them by using GC-MS. The off flavor was attributed to the presence of 1-(methylthio)-propane contributing to garlic, cabbage and rancid aroma notes. 1-(methylthio)-propane was semiquantified in raw beef from different geographical origins.**

**Key Words – 1-(methylthio)-propane, feed, off-flavor, beef.**

## I. INTRODUCTION

Tenderness is the quality that determines meat acceptability by consumers, although flavor has taken an important role in the last years [1]. The most important environmental factor influencing meat flavor is feeding [2] due to variations in fatty acid composition by the feeding prior to slaughter [3]. Due to differences in digestive systems (ruminants and non ruminants), deposition of fatty acids is different. Lamb or beef muscle has lower levels of polyunsaturated fatty acids than poultry and pork. In addition, it has been well documented that fatty acids contribute to the meat flavor through lipid auto-oxidation and thermal oxidation of especially long-chain polyunsaturated fatty acids [1]. Moreover, the thermal oxidation of long chain fatty acids can contribute to undesirable flavors [4]. Beef (off)-flavor is associated with the perception of meat palatability and is an important consumer quality factor. In the last years a liver-like off-flavor has been reported in beef and related to individual fatty acids, $Na^+$, and long chain unsaturated fatty acids while iron, heme iron and pH were not related to this off-flavor [4]. In addition, cooking temperature had a clear impact on rancidity but no direct impact on liver-like off flavor [5]. Several works have been conducted in the field of flavor production in beef. However, few works have been done to identify all compounds related to beef (off)-flavor and its origin. Therefore, the aim of this study was to identify the compounds related to off-flavor in beef from different geographical origin.

## II. MATERIALS AND METHODS

Fourteen samples (*semimembranosus* muscle) of raw beef from different geographical origins and cattle were supplied by a local market. The samples were wrapped in aluminum foil, vacuum packaged and frozen at -20 ºC until volatile analysis.

For each experiment, 1g of minced raw beef was weighted into a 20ml headspace (HS) vial sealed and 0.5 mg BHT was added. The vial was kept at 40ºC for 10 min to equilibrate its HS. Then, the SPME fibre (CAR/PDMS) was exposed to the HS while maintaining the sample at 40ºC for 5min. The compounds extracted were desorbed in the injection port (splitless mode) of the GC-FID or GC-MS for 5 min at 240ºC.

GC-FID equipped with a sniffing port was used to analyze aroma compounds as described Corral *et al.* [6].

GC-MS described by Corral *et al.* [6] was used to identify the aroma compounds. The extracted volatiles compounds were separated using a DB-624 capillary column J&W Scientific (Agilent Technologies, USA). The GC oven temperature program began at 38ºC, held for 10 min, ramped to 120ºC at 5ºC/min and then to 210ºC at 10ºC/min and held 5min at 210ºC. Mass spectra were obtained by electron impact at 70 ev and data acquired across the range 29-400 amu (scan mode). The compounds were identified as described by Corral *et al.* [6]. The quantification of 1-(methylthio)-propane was performed in SIM mode using the mass-to-charge (m/z) area of its characteristic ion 61.

## III. RESULTS AND DISCUSSION

Several samples of raw beef from different geographical origin were selected by smelling and the selection was based on the presence of an off-flavor. The selected beef samples were subjected to an olfactometry analysis by GC-O and the volatile compounds identified by GC-MS. The olfactometry analysis revealed eight aroma active zones in raw beef being identified as 2,3-butanedione, allyl methyl sulfide, 1-(methylthio)-propane, 1-(methylthio)-1-propene (Z) and four unknown compounds (Fig. 1). The compounds were classified according to the following aroma notes: acid-alcohol, earthy-undergrowth, empyreumatic, fruity-floral, green-vegetable, lactic-cheesy, plastic-chemical, sulphur-gas, not classified. The most potent odorant was evoked by 1-(methylthio)-propane described as garlic, oxidized iron, cabbage and classified as sulphur-gas aroma (Fig. 1). This compound has not been previously reported in beef. Nevertheless, it was easily detected in raw beef and classified as off-flavor.

The abundance of 1-(methylthio)-propane was quantified in 14 raw beef samples from different geographical origins (Fig. 2). In raw beef from origin 1-6 and 11 only traces of 1-(methylthio)-propane were found. However, seven samples contained a high abundance of 1-(methylthio)-propane.

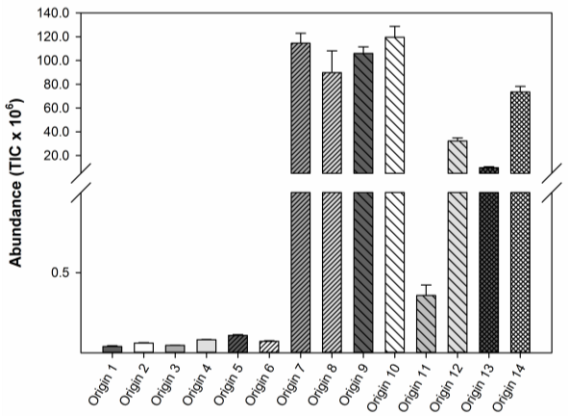


Figure 2. 1-(Methylthio)-propane abundance in raw beef from different geographical origin.

Until now, the origin of this compound in raw beef is unknown although one of the probably origins is the feeding. Only Trabue *et al.* [7] reported the presence of 1-(methylthio)-propane when they evaluated the products formed during propylene glycol fermentation in the rumen. They indicated that this compound is produced when sugars and polyols are administered to ruminants for therapeutic or nutritional purposes. A common practice in animal production industry is the use of diet supplements for beef with propylene glycol to prevent ketosis [8]. On the other hand, traces of 1-(methylthio)-propane were also detected in truffle aroma [9]. Therefore, the origin of this off-flavor compound could be the feeding practices.

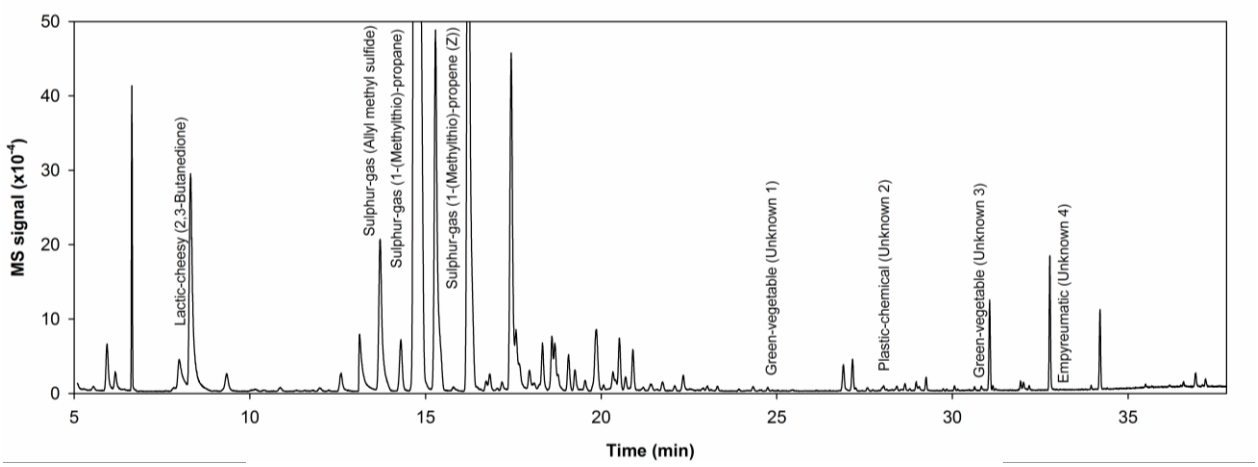


Figure 1. Cromatogram of odour active compounds in raw beef.

## IV. CONCLUSION

The identification of beef (off)-flavor characterized by a garlic-onion aroma, was attributed to the presence of 1-(methylthio)-propane. Only several samples were characterized by this odor although its origin was not elucidated. Caution should be taken in animal production systems as a probably source could be the feeding practices of cows.

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## REFERENCES

1. Calkins, C. R. & Hodgen, J. M. (2007). A fresh look at meat flavor. Meat Science 77: 63-80.
2. Shahidi, F. (1989). Flavor of cooked meat. Flavor chemistry trends and developments. Washington: DC: American Chemical Society.
3. Elmore, J. S., Warren, H. E., Mottram, D. S., Scollan, N. D., Enser, M., Richardson, R. I. & Wood, J. D. (2004). A comparison of the aroma volatiles and fatty acid compositions of grilled beef muscle from Aberdeen Angus and Holstein-Friesian steers fed diets based on silage or concentrates. Meat Science 68: 27-33.
4. Stelzleni, A. M. & Johnson, D. D. (2010). Benchmarking sensory off-flavor score, off-flavor descriptor and fatty acid profiles for muscles from commercially available beef and dairy cull cow carcasses. Livestock Science 131: 31-38.
5. Wadhwani, R., Murdia, L. K. & Cornforth, D. P. (2010). Effect of muscle type and cooking temperature on liver-like off-flavour of five beef chuck muscles. International Journal of Food Science and Technology 45: 1277-1283.
6. Corral, S., Salvador, A. & Flores, M. (2013). Salt reduction in slow fermented sausages affects the generation of aroma active compounds. Meat Science 93: 776-785.
7. Trabue, S., Scoggin, K., Tjandrakusuma, S., Rasmussen, M. A. & Reilly, P. J. (2007). Ruminal fermentation of propylene glycol and glycerol. Journal of Agricultural and Food Chemistry: 55: 7043-7051.
8. Nielsen, N. I. & Ingvartsen, K. L. (2004). Propylene glycol for dairy cows: A review of the metabolism of propylene glycol and its effects on physiological parameters, feed intake, milk production and risk of ketosis. Animal Feed Science and Technology 115: 191-213.
9. Pelusio, F., Nilsson, T., Montanarella, L., Tilio, R., Larsen, B., Facchetti, S. & Madsen, J. Ø. (1995). Headspace solid-phase microextraction analysis of volatile organic sulfur compounds in black and white truffle aroma. Journal of Agricultural and Food Chemistry 43: 2138-2143.