

# EFFECT OF TIME AND TEMPERATURE ON THE PROFILE OF VOLATILE COMPOUNDS IN BEEF PROCESSED BY THE *SOUS VIDE* METHOD

Vanessa C. Francisco<sup>1\*</sup>, Kalisa F. Silva<sup>2</sup>, Suelen C. S. Carvalho<sup>2</sup>, Stanislaw Bogusz Jr.<sup>3</sup>

Renata T. Nassu<sup>1</sup>

<sup>1</sup> Embrapa Pecuária Sudeste. São Carlos – São Paulo, Brazil.

<sup>2</sup> Faculdade de Ciências Farmacêuticas (FCFAR)/UNESP, Araraquara-São Paulo, Brazil.

<sup>3</sup> São Carlos Institute of Chemistry (IQSC)/USP, São Carlos – São Paulo, Brazil.

\*Corresponding author email: vanessacristina15@yahoo.com.br

## I. INTRODUCTION

*Sous vide* is a term of French origin that means “under vacuum”. It is a cooking technique that preserves the integrity of food by heating it for long periods at relatively low temperatures [1]. This technique is applied to extend the shelf life of food, avoiding waste and reducing the loss of liquid, nutrients and aromas sensitive to heat. Different temperatures and cooking times can modify the profile of volatile compounds and, consequently, the *flavor* of cooked meat [2]. Although there are several studies on the formation of the profile of volatile compounds in meat cooked using traditional methods, few articles report the formation of volatile compounds in beef cooked *sous vide* at low temperatures and for long periods. This work aimed to evaluate the effect of different combinations of time and temperatures on the formation of volatile compounds in beef cooked by the *sous vide* method.

## II. MATERIALS AND METHODS

M. *Biceps femoris* pieces were purchased from a commercial slaughterhouse, divided into 2.5 cm thick steaks, and vacuum packed. Cooking was carried out using the *sous vide* technique, using a thermocirculator at different combinations of time and temperature: 60°C/60 min; 60°C/360min; 65°C/210min; 70°C/60min and 70°C/360min. After cooling the samples at 3°C in an ice bath, the samples were ground in a food processor. One g of the ground sample was weighed in a glass flask with a capacity of 60 mL, and the extraction of volatile compounds was performed by the technique of solid phase microextraction (SPME) using a carboxy/polydimethylsiloxane (CAR/PDMS) *fiber* as stationary phase. Gas chromatography coupled to mass spectrometry (GC-MS) was used to separate and identify volatile compounds in the samples, using a DB-5 MS column (5% phenyl, 95% dimethylpolysiloxane) 60 m x 0.25 mm internal diameter and one µm stationary phase thickness. The oven temperature started at 40 °C, increasing 4 °C min<sup>-1</sup> to 180 °C, 10 °C min<sup>-1</sup> to 280 °C, remaining at this temperature for 5.3 min. Helium (He) was used as carrier gas. The compounds were identified through their spectra and compared with those of the NIST library database. To confirm, an n-alkane (C7-C30) solution (Supelco, Bellefonte, PA) was injected into the equipment under the same conditions as the samples to obtain the programmed linear retention temperature index (LTPRI) of volatile compounds. Experimental identification was performed by comparing the LTPRI and mass spectra with literature reports, with a minimum similarity of 85%. A qualitative analysis was applied to analyze the obtained data.

## III. RESULTS AND DISCUSSION

A total of 80 volatile compounds were identified in beef samples cooked by the *sous vide* method at different time and temperature combinations. The compounds were classified as alcohols (n=12), aldehydes (n=13), carboxylic acids (n=6), esters (n=17), hydrocarbons (n=14), ketones (n=11),

lactone(n=1), sulfur compounds (n=2) and terpenes (n=2). The number of compounds of each chemical class per treatment can be seen in Table 1.

Table 1 – Chemical class of volatile compounds in beef samples in *sous vide* cooked at different time and temperature combinations.

Class	60°C/60min	60°C/360min	65°C/210min	70°C/60min	70°C/360min
Alcohol	4	6	9	8	7
Aldehyde	6	11	8	7	7
Carboxylic acid	1	2	5	2	3
Ester	6	13	15	7	7
Hydrocarbon	7	12	3	3	5
Ketone	7	9	9	7	6
Lactone			1		
Sulfur compound		2	2	2	2
Terpene			2		
<b>Total compounds</b>	31	55	54	36	37

In the distribution of different volatile compound classes under various cooking conditions, it is observed that the treatment 60°C/360min and 65°C/210 min resulted in the highest total detected number of compounds, with notably higher counts of esters, aldehydes and ketones, followed by alcohols. Conversely, fewer compounds were identified in the treatment with a shorter time and temperature (60°C/60min). Some classes, such as lactones and terpenes, were only detected under specific conditions (65°C/210 min). Increasing the cooking temperature over long periods influences flavor development through the Maillard's reaction and lipid oxidation [3]. According to Roldan [4], *sous-vide* cooking at moderately high temperatures for extended periods of time stimulates the formation of volatile compounds from reactions involved in amino acids that form a desirable meaty *flavor*.

#### IV. CONCLUSION

The volatile compounds profile in beef cooked by the *sous vide* method was influenced by cooking time and temperature. This highlights the importance of controlling cooking parameters to achieve desired flavor profiles in beef *sous vide* cooking.

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