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Odorant properties of beef: Chemometric and bioinformatics modeling

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Abstract

The release of volatile compounds through the beef generating the characteristic odors and flavors is part of our daily experience. In current studies with food matrices, the scientific effort was centered on the aroma compounds perceived by consumers, but the information about the biochemistry and metabolic source of these odorants is not totally available. It is well known, that many of these compounds can be produced by maturation changes. However, the beef has volatile compounds before the maturation changes, arising the question: How the meat produces these odorant compounds? The objective was proposing a model to describe odorant properties and volatile compounds released by beef. Volatile compounds of beef (*Bos taurus*, *M. longissimus dorsi*) were measured using CG/MS-SPME (Gas Chromatography / Mass Spectrum - Solid Phase Micro Extraction). Compounds identification was performed on the basis of the Mass Spectral MS-library (NIST, USA). A bioinformatics database (KEGG, Japan) was used to reconstruct the volatile metabolism of fresh-meat. Chemometrics approach based on PCA (Principal Component Analysis) was made to modeling the relationship between different odorants. A graph model was made matched odorants identified in beef with compounds described in KEGG database (querying *Bos taurus* section). Pathways were linked through a central branch mediated by glycolysis. The model indicates that glycolysis likely triggers the release of odorants, such as occurs with the lactate production in *rigor-mortis*. Chemometric analysis of chromatograms show that volatile profile changes in the *rigor-mortis* associated to glycolytic activity and pH decreasing. It is very important to understand the odorant properties of beef, because this information could be used to develop technologies to certificate the beef and to enhance the flavor.

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Keywords: Beef; Bioinformatics; Databases; Red meat; Volatile organic compounds.

1. Introduction

The release of volatile organic compounds (VOCs) through the meat generating the characteristic odors is part of our daily experience. It is well known, that many of these compounds can be produced by

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maturation changes. However, the meat has a volatile-profile before the maturation changes, arising the question: Why the meat produces these compounds?. It can be speculated that biochemical origin of the VOCs can be part of a sophisticated metabolic system, similar to the emission of volatiles in plants [1].

In current studies with meat samples, the scientific effort was centered on the aroma compounds perceived by consumers. But the information about the biochemistry and metabolic source of these odorants is not totally available. It is well known, that biological components of the meat has the potential to interact with VOCs. This effect is important because can altered the perception of the aromas by the consumers. This VOC binding is demonstrated by carbohydrates, lipids and proteins [2]. Nevertheless, each food has a characteristic volatile-profile released by intrinsic biochemical reactions. Many times, these odorants are the reason for the fresh aroma of the food.

Since that VOCs released by foods can be produced for the metabolic activities, different kinds of VOCs likely are produced for different metabolic pathways. When the animal (bovine) is slaughtered, these VOCs inside the muscle are released outside producing the characteristic odor of the meat. In addition, the VOCs can be produce by external factors, such as microbial activity, chemical reactions, environmental contaminations, and others. It is very important to understand the biochemical origin of the odorants, because this information could be used to develop technologies to certificate the beef and to enhance the flavor of fresh-meat.

2. Materials & Methods

2.1. Gas Chromatography

Three bovines or six half-carcasses (*Bos taurus*, Holstein Friesian, *M. longissimus dorsi*) were sampled in pre and post *rigor-mortis*. Volatile compounds of beef were measured using CG/MS-SPME (Gas Chromatography / Mass Spectrum - Solid Phase Micro Extraction). Chromatographic analyses were made using the GC/MS-SPME method described by Martin et al. [3], in a Hewlett-Packard HP 6890 gas chromatography (with a HP MD5973 quadrupole mass spectrometer). Compounds identification was performed on the basis of the Mass Spectral MS-Library (NIST, USA).

2.2. Chemometric and bioinformatics analysis

Metabolic origin of the VOCs was studied with a bioinformatics approach [4], using the biotechnology database KEGG (Kyoto Encyclopedia of Genes and Genomes). KEGG is a free database available in <http://www.genome.jp/kegg> (Kanehisa Laboratory, Kyoto University, Japan). Chemometrics analysis based on PCA (Principal Component Analysis) was made using SIMCA-P Software (Umetrics, Sweden).

3. Results & Discussion

Previously to develop a biochemical modeling, the VOCs reported in literature were reviewed. VOCs released by beef and meat products are shown in Table 1, together putative metabolic pathways described in KEGG bioinformatics databases. Since that odorants compounds could be released from beef by various cellular organisms (e.g. lactic acid bacteria after deboning), the metabolic pathways identified were classified as *Bos taurus* or LAB (lactic acid bacteria) considering the genes sequenced in KEGG.

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