MEAT SPECIES AUTHENTICATION OF CHICKEN, BEEF, PORK, AND THEIR COMBINATIONS IN SAUSAGE BASED ON THE VOLATILE COMPOUND PROFILES

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Bogor, June 2025

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RINGKASAN

FARAH DONNABELLA AZARINE. Autentikasi Spesies Daging Ayam, Sapi, Babi, dan Kombinasinya pada Sosis berdasarkan Profil Senyawa Volatil. Dibimbing oleh DIAS INDRASTI dan NANCY DEWI YULIANA.

Pemalsuan daging masih sering terjadi, terutama dengan alasan ekonomi. Di Indonesia, harga daging sapi relatif lebih mahal dibandingkan dengan daging ayam atau babi sehingga praktik substitusi daging sapi dengan daging ayam maupun babi masih ditemukan. Sebagai negara dengan mayoritas penduduk Muslim, isu ini menjadi sangat penting dalam konteks keamanan pangan dan jaminan kehalalan pangan. Berbagai metode telah dikembangkan untuk mengidentifikasi spesies daging dalam produk pangan, seperti PCR, ELISA, dan spektroskopi. Namun, pendekatan volatilomik mulai dikaji sebagai metode alternatif yang menawarkan kecepatan dan non-destruktif. Sosis merupakan produk olahan daging dengan aroma khas yang dihasilkan oleh senyawa volatil sehingga berpotensi dimanfaatkan untuk autentikasi spesies daging. Penelitian ini bertujuan untuk mengidentifikasi senyawa volatil penanda spesies daging dari enam jenis sosis segar berbasis daging ayam, sapi, babi, serta kombinasinya. Sampel sosis diekstraksi menggunakan teknik *headspace-solid phase microextraction* (HS-SPME) dan dianalisis dengan *gas chromatography–mass spectrometry* (GC–MS). Data profil senyawa volatil dianalisis menggunakan *principal component analysis* (PCA) untuk melihat pola pemisahan alami antar kelompok dan *orthogonal partial least squares-discriminant analysis* (OPLS-DA) untuk mengidentifikasi senyawa penanda. Sebanyak 124 senyawa volatil teridentifikasi dan diklasifikasikan ke dalam 14 kelompok, dengan alkohol dan aldehida sebagai senyawa dominan (25–38%). Model OPLS-DA menunjukkan pemisahan yang cukup jelas antara kelompok sosis berdasarkan jenis dan kombinasi spesies daging. Senyawa volatil penanda diidentifikasi menggunakan nilai *variable importance in projection* (VIP) >1 dan koefisien korelasi positif. Ditemukan senyawa volatil penanda *hexanal* dan *1,3-octadiene* untuk sosis ayam dan sapi, *2-penten-1-ol, (Z)-; 2-hexenal; 1-pentanol;* dan *furan, 2-pentyl-* untuk sosis babi dan ayam-babi, serta *1-undecanol, octane, heptane, 2,4-dimethyl-*, dan *1-octene, 6-methyl-* untuk sosis sapi-babi dan ayam-sapi-babi. Penemuan ini menunjukkan bahwa analisis volatilomik berbasis GC–MS dengan pendekatan multivariat dapat digunakan sebagai pendekatan pendukung dalam upaya autentikasi spesies daging dalam produk olahan seperti sosis.
Kata kunci: autentikasi, OPLS-DA, SPME-GC-MS, sosis, volatil

SUMMARY

FARAH DONNABELLA AZARINE. Meat Species Authentication of Chicken, Beef, Pork, and Their Combinations in Sausage Based on the Volatile Compound Profiles. Supervised by DIAS INDRASTI and NANCY DEWI YULIANA.

Meat counterfeiting still occurs frequently, primarily for economic reasons. In Indonesia, beef is relatively more expensive than chicken or pork, so the practice of substituting beef with chicken or pork is still found. As a Muslim-majority country, this issue is critical in the context of ensuring the food safety and halal security. Various methods, such as PCR, ELISA, and spectroscopy, have been developed to identify meat species in food products. However, the volatilomic approach has begun to be studied as an alternative method that offers speed and is non-destructive. Sausage is a processed meat product with a distinctive aroma produced by volatile compounds, so it can potentially be used for meat species authentication. This study aims to identify volatile compounds that mark meat species in six types of fresh sausages made from chicken, beef, pork, and their combinations. Sausage samples were extracted using the headspace-solid phase microextraction (HS-SPME) technique and analyzed by gas chromatography–mass spectrometry (GC–MS). Volatile compound profile data were analyzed using principal component analysis (PCA) to see the natural separation pattern between groups and orthogonal partial least squares-discriminant analysis (OPLS-DA) to identify marker compounds. A total of one hundred and twenty-four volatile compounds were identified and classified into 14 groups, with alcohols and aldehydes as the dominant groups (25–38%). The OPLS-DA model showed a fairly clear separation between sausage groups based on the type and combination of meat species. Marker volatile compounds were identified using variable importance in projection (VIP) values >1 and positive correlation coefficients. Volatile marker compounds were found to be hexanal and 1,3-octadiene for chicken and beef sausages, 2-penten-1-ol, (Z)-; 2-hexenal; 1-pentanol; and furan, 2-pentyl- for pork and chicken-pork sausages, and 1-undecanol; octane; heptane, 2,4-dimethyl-; and 1-octene, 6-methyl- for beef-pork and chicken-beef-pork sausages. These findings indicate that GC–MS-based volatilomic analysis with a multivariate approach can be used as a supporting approach in efforts to authenticate meat species in processed products such as sausages.

Keywords: authentication, OPLS-DA, sausage, SPME-GC-MS, volatile

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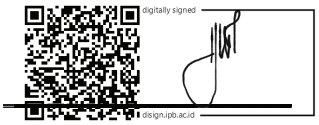

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PREFACE

The author would like to express his praise and gratitude to Allah subhanaahu wa ta'ala for all His gifts so that this scientific work was completed. The theme was chosen in the research from August 2023 to January 2025 under the title "Meat Species Authentication of Chicken, Beef, Pork, and Their Combinations in Sausage Based on the Volatile Compound Profiles".

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Hopefully, this scientific work will be helpful for those who need it and for the advancement of science.

Bogor, Juni 2025

Farah Donnabella Azarine

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