# DETEKSI DINI LARVA LALAT BUAH SALAK *Bactrocera* spp. (Diptera: Tephritidae) MENGGUNAKAN *Electronic Nose*

**Oka Dwi Handaru**
20/471783/SPN/00688

## Intisari

Kontaminan lalat buah dalam buah salak menghambat ekspor komoditas tersebut di Indonesia. Alat *electronic nose* (*e-nose*) yang *portabel*, perlu dikembangkan sebagai metode pemeriksaan yang cepat, sensitif, akurat, dan tidak merusak buah salak. Tujuan penelitian ini adalah untuk mengetahui spesies lalat buah yang menyerang buah salak, mengetahui deskripsi profil senyawa buah salak sehat dan yang luka akibat terserang lalat buah dan luka mekanis, dan menguji kemampuan *e-nose* mendeteksi dini keberadaan larva lalat buah di dalam buah salak. Penelitian diawali dengan identifikasi spesies lalat buah salak dari populasi alami, dilanjutkan pengujian kandungan senyawa kimia buah salak menggunakan GC-MS dan pengujian *electronic nose* (*e-nose)* diintegrasikan dengan algoritma *machine learning* yang menunjukkan sistem yang cepat, sensitif dan akurat dalam deteksi larva lalat buah. Data hasil *e-nose* dianalisis dengan model klasifikasi Extra Tree, SVM (RBF), LDA, QDA dan KNN. Hasil Penelitian ini adalah: 1) Lalat buah yang menyerang buah salak pada penelitian ini adalah *Bactrocera carambolae*. 2) Senyawa pada buah salak yang terserang lalat buah yaitu: 4-Heptanol, 4-methyl- pada hari pertama setelah infestasi, D-Limonene pada hari kedua, Methyl acetate, Etyl acetate, dan Methyl 2-methyl-2-butenoate pada hari keempat yang tidak terdapat pada perlakuan kontrol. konsentrasi senyawa kimia pada buah salak yang luka terserang larva lalat buah pada hari kesatu, kedua, ketiga dan keempat setelah perlakuan mengalami peningkatan seperti: Methyl isovalerate, Methyl 3-methylcrotonate, d-(-)-Citramalic acid, dimethyl ester, 2(3H)-Furanone, dihydro-4,5-dimethyl-, 2H-Pyran-2-one, tetrahydro-4-methyl-, Methyl 3-hydroxy-3-methylbutanoate, Methyl butyrate, Decane, 3,7-dimethyl-, dan 3,6-Undecandione. 3) Performa *e-nose* dengan model klasifikasi *Extra tree* dan QDA dengan fitur gradien memberikan hasil yang terbaik dari model klasifikasi yang lainnya dengan performa akurasi CV masing-masing 71,95 ± 4,95 dan 71,52 ± 4,44 untuk pengujian tiga label. Sedangkan untuk pengujian dua label dengan akurasi CV masing-masing sebesar 85,00 ± 6,33 dan 85,96 ± 5,93.

**Kata kunci:**

Bactrocera spp, *biomarker*, deteksi cepat, deteksi non-destruktif, *electronic nose*, salak

# EARLY DETECTION OF FRUIT FLY LARVAE *Bactrocera* spp. (Diptera: Tephritidae) IN THE SNAKE FRUIT USING AN ELECTRONIC NOSE

**Oka Dwi Handaru**
20/471783/SPN/00688

## Abstract

The presence of fruit fly contaminants in snake fruit *(Salacca zalacca* (Gaertner) Voss) has been identified as a significant impediment to the exportation of this commodity from Indonesia. The development of a portable electronic nose is important as a rapid, precise, and non-destructive inspection method for *S.zallaca*. The objective of this study was to first determine fruit flies species that infest *S.zallaca*. Second, determine and describe compound profiles of healthy *S.zallaca*, those infested by fruit flies or mechanically injured; and third, to test an e-nose ability for early detection of fruit fly larvae presences in *S.zallaca*. The research begun with identifying fruit fly species that infect *S.zallaca* in the field. This was followed by identifying chemical compounds from *S.zallaca* with different injury status using GC-MS. Additionally, an electronic nose (e-nose) integrated with machine learning algorithms was tested. This combination demonstrated a fast, sensitive, and accurate system for detecting fruit fly larvae in *S.zallaca*. The e-nose result was then subjected to analysis using a variety of classification models, including Extra Tree, SVM (RBF), LDA, QDA, and KNN. The e-nose result data was afterwards subjected to analysis using a variety of classification models, including Extra Tree, SVM (RBF), LDA, QDA, and KNN. Results of this study found that *Bactrocera carambolae* was identified as a fruit fly species infecting *S.zallaca*. Secondly, the *S.zallaca* fruit infested by fruit flies emit different volatile compound mixtures depending on days after fruit were infested. Volatiles detected from one, two, and four days infested fruits included 4-heptanol, 4-methyl, D-limonene, methyl acetate, ethyl acetate, and methyl 2-methyl-2-butenoate which were not detected in untreated controls. In addition, concentration of certain chemical compounds from one, two, and four days infested fruits increased which included methyl isovalerate, methyl 3-methylcrotonate, d-(-)-citramalic acid dimethyl ester, 2(3H)-furanone, dihydro-4,5-dimethyl-2H-pyran-2-one, tetrahydro-4-methyl-2H-pyran-2-one, methyl 3-hydroxy-3-methylbutanoate, methyl butyrate, decane, 3, 7-dimethyl and 3,6-undecandione. Thirdly, e-nose performance using extra tree and QDA classification models with gradient features yielded optimal results and coefficient of variation (CV) accuracy of 71.95 ± 4.95 and 71.52 ± 4.44, respectively, for three labels. In the following experiment, two labels resulted in CV of 85.00 ± 6.33 and 85.96 ± 5.93, respectively.

**Keyword:**

*Bactrocera* spp, biomarker, rapid detection, non-destructive detection, electronic nose, snake fruit