KAJIAN BAKTERI PENGHASIL 1-AMINOCYCLOPROPANE-1-CARBOXYLATE (ACC) DEAMINASE SEBAGAI PEMACU PERTUMBUHAN TANAMAN KEDELAI PADA CEKAMAN SALINITAS

INTISARI

Tanaman yang terpapar oleh cekaman umumnya mensintesis etilen dan berdampak pada penghambatan pertumbuhannya. Peningkatan konsentrasi etilen pada tanaman dapat diatasi dengan memanfaatkan bakteri penghasil ACCD (*1-aminocyclopropane-1-carboxylate deaminase*). Penelitian bertujuan untuk mengisolasi, mengidentifikasi, dan mengkarakterisasi bakteri lokal spesifik penghasil enzim ACCD serta mengetahui peran bakteri penghasil ACCD terpilih dalam meningkatkan pertumbuhan kedelai pada cekaman salinitas.

Bakteri diisolasi dari bagian akar tanaman pangan, holtikultura, dan perkebunan. Isolasi bakteri dilakukan pada akar steril permukaan dengan metode *surface plating*. Seleksi dilakukan pada medium minimal Dworkin–Foster (DF) padat dan cair dengan penambahan ACC/AIB sebagai sumber nitrogen. Identifikasi isolat dilakukan secara morfologis dan sekuensing gen 16S rRNA. Karakterisasi ekologi dilakukan dengan menumbuhkan bakteri pada variasi pH, suhu, sifat aerobisitas, dan salinitas. Karakterisasi fisiologi meliputi aktivitas ACCD, penambatan nitrogen, pelarutan fosfat, produksi IAA, penggunaan sumber karbon, antagonisme patogen, ketahanan terhadap logam berat Cr^{6+}, dan resistensi antibiotik. B*ioassay* meliputi pengujian produksi etilen, α-ketobutirat, pertumbuhan kecambah (tinggi, panjang akar, diameter, dan berat kering), persentase perkecambahan, dan kandungan pigmen kedelai tercekam salinitas.

Hasil isolasi dari perakaran tanaman diperoleh 120 isolat bakteri. Berdasarkan hasil pertumbuhan kualitatif pada medium minimal *DF Salts* yang ditambah dengan ACC/AIB, dipilih 12 isolat yang menunjukkan pertumbuhan terbaik dibandingkan dengan isolat lainnya. Berdasarkan sekuen gen 16S rRNA, isolat BK1 teridentifikasi sebagai *Sphingobacterium* sp., isolat CB2, TW7, PIC5, PIC11 sebagai *Bacillus* sp., isolat CK4, KD6.2 sebagai *Pantoea* sp., isolat KW3 sebagai *Enterobacter* sp., isolat KS12, KS16.2, PIR3C sebagai *Pseudomonas* sp., isolat PIR5 sebagai *Stenotrophomonas* sp., dan isolat PCM 8 sebagai *Raoultella* sp. Semua strain bakteri menunjukkan pertumbuhan optimal pada pH 6-8, suhu 25-30°C, dan kebutuhan oksigen aerob - anaerob fakultatif. Kedua belas isolat mempunyai aktivitas ACCD berkisar 123,75-1.461,44 nmol α-ketobutirat/mg/jam, aktivitas nitrogenase 2,95-467,84 nmol/g/jam, indeks pelarutan fosfat 1,1-3,04 dan produksi IAA berkisar 0,11-10,33 mg/L/jam. Toleransi terhadap NaCL sampai dengan konsentrasi 3% dan logam berat Cr^{6+} sampai dengan konsentrasi 300 mg/L. Hasil *bioassay* pada kecambah kedelai dengan konsentrasi NaCl 122 mM menunjukkan isolat bakteri *Raoultella* sp. PCM8 mampu meningkatkan persentase perkecambahan, kandungan klorofil b dan menurunkan diameter batang. Isolat bakteri *Pseudomonas* sp. PIR 3C mampu meningkatkan tinggi batang, panjang akar, berat kering, kandungan klorofil a, dan karotenoid. Hasil penelitian menunjukkan bahwa strain *Raoultella* sp. PCM8, *Pseudomonas* sp. PIR3C, dan *Pseudomonas* sp. KS12 merupakan bakteri yang potensial digunakan dalam pengembangan pupuk hayati terutama untuk tanaman yang tercekam lingkungan.

Kata kunci: ACC deaminase, bakteri, kedelai, cekaman salinitas, etilen.

STUDY OF 1-AMINOCYCLOPROPANE-1-CARBOXYLATE (ACC) DEAMINASE-PRODUCING BACTERIA FOR PROMOTING THE PLANT GROWTH OF SOYBEAN UNDER SALINITY STRESS CONDITION

ABSTRACT

Plants that are exposed toward the stress, generally synthesize ethylene and have a negative impact on plant growth. Increased ethylene concentration in plants can be overcome by utilizing ACCD-producing bacteria. The study was aimed to isolate, identify, and characterize the specific local bacteria producing ACCD enzymes and determine the role of the selected bacteria in soybean plant growth under salinity stress condition.

Bacteria were isolated from the roots of food crops, horticulture, and plantations. Isolation was conducted on surface sterilized roots using surface plating method. Selection was carried out on a solid and liquid minimal medium DF salts supplemented with ACC/AIB as a nitrogen source. Identification of isolates were carried out morphologically and molecularly by 16S rDNA sequencing. Ecological characterization was conducted by growing bacteria in a medium with variations in pH, temperature, aerobicity, and salinity. Physiological characterization includes ACCD activity, nitrogen fixation, phosphate solubilization, IAA production, carbon sources utilization, pathogenic antagonism, resistance to heavy metals Cr^{6+}, and antibiotic resistance. Bioassay parameters were the measurement of ethylene production, α-ketobutyrate, seedling growth (shoot lenght, root length, stem diameter, and dry weight), germination percentage, and pigment content of salinity-stressed soybean.

From this work, 120 bacterial isolates were successfully isolated. Based on the results of qualitative growth on the minimal medium DF salts supplemented with ACC/AIB, 12 isolates were selected which showed the best growth compared to the other isolates. Based on 16S rDNA sequence, BK1 isolate was identified as *Sphingobacterium* sp., CB2, TW7, PIC5, PIC11 isolate as *Bacillus* sp., isolate of CK4, KD6.2 as *Pantoea* sp., KW3 isolate as *Enterobacter* sp., isolate of KS12, KS16.2, PIR3C as *Pseudomonas* sp., PIR5 isolate as *Stenotrophomonas* sp., and PCM8 isolate as *Raoultella* sp. All bacterial strain demonstrated optimal growth in pH 6-8, temperature 25–30˚C, and oxygen requirement of aerobic to facultative anaerobic. Twelve bacterial strains were exhibited the ACCD activity 123,75-1.461,44 nmol α-ketobutyrate/mg/hour, nitrogenase activity 2,95-467,84 nmol/g/hour, phosphate solubilizing index 1,1–3,04 and IAA (Indole-Acetic Acid) production level 0,11-10,33 mg/L/hour. Tolerance to NaCl up to a concentration of 3%, Cr^{6+} tolerance up to 300 mg/L. Bioassay results on soybean seedling with 122 mM NaCl treatment showed that *Raoultella* sp. PCM8 was able to increase germination percentage, chlorophyll b content, and reduce stem diameter. *Pseudomonas* sp. PIR3C could increase shoot length, root length, dry weight, chlorophyll a content, and carotenoids. The results suggested that *Raoultella* sp. PCM8, *Pseudomonas* sp. PIR3C, and *Pseudomonas* sp. KS12 were potential strains to be used in biofertilizer development especially salinity-stressed crops.

Keywords: ACC deaminase, bacteria, soybeans, salinity stress, ethylene.