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주최 / 주관 전남대학교 농업생명과학대학
College of Agriculture and Life Sciences Chonnam National University

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[1]전남대학교 대학원 지역·바이오시스템공학과 & BK21(4단계) 기후지능형 간척지 농업 교육연구팀

[2]전남대학교 농업생명과학대학 기후변화대응농생명연구소

[3]전남대학교 산학협력단

초록

최근 가금 스마트팜은 ICT 기술을 이용하여 원격으로 어디서나 육계의 성장을 관찰하고 자동화 기술을 통한 적정 생육 환경 관리로 생산성 및 품질 향상을 추구 하고 있다. 또한 육계사 내의 미기상을 원격으로 제어할 수 있도록 하는 1세대 스마트팜의 편의성 개선을 넘어서 육계사내 미기상 및 환기 장치의 데이터를 기반으로 인공지능 기술을 접목하여 가축의 최적 성장 모델 개발이 이루어지고 있다. 이에 본 연구에서는 2세대 스마트팜 개발로서 육계의 최적 환경을 위한 제어 알고리즘 개발에 앞서 실내 기온 예측 모델을 개발하고 검증하였다. 영역 기반 (Zone-based)의 미기상을 제어하기 위해 육계사 내외부 기온과 환기팬, 온풍기, 환기 유입구 등의 제어 장치 데이터를 사용하였다. 예측 모델은 세 가지 기계학습 모델과 열전달 이론에 기반한 역학적 모델을 사용하였다. 기계학습의 경우, 인공신경망, 랜덤포레스트, 서포트 벡터 머신 알고리즘을 이용하였으며 베이지안 최적화를 통해 각 알고리즘의 하이퍼 파라미터를 최적화시켰다. 역학적 모델의 경우, 시공간적 불균일성을 보완ㄴ하기 위해 열에너지 증감식에 확산 지수 (u_i)와 시간 지연 지수 (d_i)를 도입하였으며 각 지수는 유전 알고리즘으로 각 지수를 추정 및 탐색하였다. 모든 모델은 이전 시간의 실내 기온을 기반으로 1분 동안의 기온 변화를 통해 Δt이후의 기온을 예측하여 1분, 10분, 30분, 1시간 동안의 기온을 예측할 수 있도록 설계하였다. 1분후의 내부 기온을 예측하는 모델의 결과는 모든 예측 모델에서 R^2가 0.99이상, RMSE가 0.306℃이하로 높은 예측 성능을 보였다. 하지만, 1시간과 같이 장기간 예측의 경우 역학적 모델이 R^2가 0.934, RMSE가 0.841℃로 가장 좋은 예측 성능을 보였다. 이전 시간의 실내 기온을 기반으로 1분 후의 기온을 예측하므로 오차가 중첩되는 장기간의 예측은 물리적 열에너지 증감식과 시간 지연 지수를 도입한 역학적 모델이 가장 높은 정확도를 나타냈다. 본 연구의 결과를 통해 장기간동안의 실내 기온을 예측할 수 있으며, 향후 2세대 스마트팜의 미기상 제어 알고리즘에 활용될 수 있을 것으로 기대된다.

P-02

농업활동으로 배출된 암모니아의 대기 확산 평가를 위한 AERMOD 모델링

이세연[1], 박진선[2], 최락영[1], 홍세운[1+]

[1]전남대학교 대학원 지역·바이오시스템공학과 & BK21(4단계) 기후지능형 간척지 농업 교육연구팀

[2]전남대학교 농업생명과학대학 기후변화대응농생명연구소

초록

국내 미세먼지 (PM_{10}) 배출량은 지속적으로 감소하는 추세이지만, 2차 생성 미세먼지 발생량 비중이 높은 초미세먼지 ($PM_{2.5}$)의 농도는 개선되지 않고 있다. 암모니아 (NH_3)는 2차 초미세먼지의 전구물질로 알려져 미세먼지의 저감을 위한 중요한 역할로 주목되고 있다. 2019년 CAPSS 배출량에 따르면 국내 농업부문에서 암모니아가 약 25만 톤 배출되어, 전체 배출량 중 79.8%를 차지하는 것으로 밝혀져 암모니아의 주요 배출원은 농업활동으로 보고되고 있다. 농업활동이 활발한 농촌지역은 주로 지형이 평탄하고, 건물이 높지 않아 암모니아가 인근 지역으로 확산되기 쉽고, 인접 주거 지역의 거주민들의 호흡계 계통의 질병을 유발할 수 있다. 따라서 본 연구에서는 미국 EPA의 AERMOD를 활용하여 암모니아의 대기 중 확산을 예측하고 암모니아가 인근 도심지역에 미치는 영향을 파악하였다. 대상 지역은 광주광역시와 인근 지역인 5개의 시군으로 하여 주 농업활동인 비료사용농경지에서 발생한 암모니아가 광주광역시 생활권 대기 환경에 미치는 영향을 분석하였다. 농경지 비료 사용으로 배출된 암모니아는 1시간 평균 농도의 연중 최대값이 0.1ppm에 이르지만, 광주광역시 내에서의 대기 중 농도는 0.02ppm 이하로 나타나 광주광역시 대기오염에는 거의 영향을 미치지 않고, 발생원 인근에서만 영향을 미치는 것으로 판단되었다.

P-03

돈사 구조 및 환기시스템별 환기 효율성 분석을 위한 추적가스 실험

이세연[1], 박진선[2], 최락영[1], 홍세운[1+]

[1]전남대학교 대학원 지역·바이오시스템공학과 & BK21(4단계) 기후지능형 간척지 농업 교육연구팀

[2]전남대학교 농업생명과학대학 기후변화대응농생명연구소

초록

우리나라는 사계절이 뚜렷하여 돼지를 사육할 때, 환기조절을 통한 돈사 내 적정 온도 유지가 매우 중요하다. 환기가 잘 이루어지지 않으면 돼지의 질병을 초래하고, 작업자의 건강을 해쳐 노동생산성이 크게 감소할 수 있기 때문에, 돼지와 작업자의 활동 공간에서 환기 효율이 좋아야 한다. 본 연구는 국립축산과학원에서 신축한 환경조절형 돈사를 대상으로 환기량이 5,000CMH, 2,000CMH 일 때, 돈사 구조(가변형, 반슬랏 피트 구조) 및 입기(복도, 중천장, 덕트), 배기(측면, 굴뚝) 조합에 따른 돈사 내부 지점별 환기 효율성을 분석하였다. 환기 효율성은 이산화탄소(CO_2)를 사용한 추적가스법(Tracer Gas Decay: TGD)을 활용하였고, 돼지의 활동 높이(30cm) 9개 지점, 작업자 활동 높이(150cm) 5개 지점에서 공기교환량(Air Change Hour; ACH)을 산출하였다. 복도입기구를 조합하였을 때 복도 근처보다 배기팬 근처에서, 덕트입기구는 덕트의 양쪽 측면에서, 중천장입기구는 비교적 모든 지점에서 고르게 공기교환량이 높게 나타났고, 굴뚝배기구보다 측면배기구로 환기했을 때 돼지 활동 공간에서 환기 효율성이 높게 나타났다. 전반적으로 작업자의 활동 공간에서의 공기교환량이 돼지 활동 공간보다 높게 나타났고, 돈방의 규모가 작아 그 차이는 크지 않는 것으로 예측되었다. 본 연구는 축산 현장의 다양한 구조 및 환기시스템별 동물 사육 환경 개선을 위한 연구의 기초 데이터로 활용 가능하다.

P-04

Identification of a candidate gene responsible for male sterility conferred by CMS-T cytoplasm in onion (*Allium cepa* L.) and development of molecular markers for detection of CMS-T cytoplasm

Wooseong Ahn, Sunggil Kim

Department of Horticulture, Biotechnology Research Institute, Chonnam National University, Gwangju 61186, Republic of Korea

ABSTRACT

Cytoplasmic male sterility (CMS) has been exclusively used as an emasculation tool in seed production of hybrids in onion (*Allium cepa* L.).Three types of onion CMS (CMS-S, CMS-R, and CMS-T) have been used in hybrid onion breeding. Male sterility conferred by both CMS-S and CMS-R is likely induced by open reading frame (*orf) 725*, a chimeric gene. However, this gene was not detected in onion accessions containing CMS-T cytoplasm. Instead, a region showing high homology with *orfA501*, which is located in the 3′ end of *orf725*, was detected in CMS-T. A novel chimeric gene, which we named *orf219*, was identified by genome walking PCR amplification based on the *orfA501* homolog. The 684-bp open reading frame of *orf219* consisted of an 128-bp of exon 1 of *atp1* and a 556-bp sequence of an *orfA501* homolog. The high-copy-number *orf219* was detected only in the CMS-T cytoplasm (T cytotype). Analysis of RT-PCR products showed normal transcription of *orf219* and eight RNA editing sites, one of which created a stop codon, resulting in a shorter amino acid sequence upon translation. Sequences of four hypervariable regions in the chloroplast genome and the organization of syntenic blocks in mitochondrial genome indicated that CMS-T was very closely related to the normal (N) male-fertile and CMS-R cytotypes. Based on these findings, new molecular markers were developed for the identification of cytotypes CMS-T, -R, -S, and -N. Cytotypes of 424 diverse onion accessions were identified using six molecular markers. The CMS-S and CMS-R cytotypes predominated among the analyzed accessions. In contrast, only five accessions possessed CMS-T, supporting early reports that CMS-T is rarely used in hybrid-onion breeding.

P-05

Identification of viruses infecting lily by nanopore sequencing

Hyo-Jeong Lee, Rae-Dong Jeong
Department of Applied Biology, Chonnam National University, Gwangju 61186, Korea

ABSTRACT

Lilies (*Lilium* spp.) are regarded as one of the most important ornamental flower crops in Korea. Most lilies are transmitted by the virus through infected bulbs, and viral diseases cause serious economic losses as the yield of lily bulbs is reduced. Previous studies have shown that various diagnostic techniques and high-throughput sequencing methods have been applied to diagnose viruses infecting lilies. Based on Oxford Nanopore Technologies (ONT), the MinION is a compact, portable device for sequencing. In this study, a total of 566,812 reads were generated using the ONT platform from lily leaf samples exhibiting leaf curling and mosaic pattern symptoms, and lily mottle virus, lily symptomless virus, and plantago asiatica mosaic virus were identified. As a result of genome assembly of reads obtained through ONT, 100% coverage and 90.3-93.4% identity were obtained. Therefore, we show that the ONT platform is a promising tool for virus diagnosis and characterization in lily samples.

P-06

The cellulose paper-based nucleic acid extraction and recombinase polymerase amplification for rapid detection of plant viruses and viroids

Hyo-Jeong Lee, Rae-Dong Jeong
Department of Applied Biology, Chonnam National University, Gwangju 61186, Korea

ABSTRACT

Plant viruses and viroids are among the main factors limiting crop production and cause substantial economic losses. In order to prevent the rapid spread of plant viruses and effectively control diseases caused by viruses, more sensitive and reliable quick detection methods is required. The development of several molecular diagnostic tools for pathogens has a remarkable increase over the past few decades. Among various methods, recombinase polymerase amplification (RPA) is a technology that can detect viral diseases rapid, simply, reliably, and sensitively without a thermocycler. The RPA technique has the advantage of being implemented in a field-based scenario because it is performed under isothermal conditions. However, in order to effectively diagnose viral diseases infield conditions, the establishment of a simple nucleic acid extraction method must first be solved. To address this problem, various methods for extracting nucleic acids were investigated in the reference. Among them, the method of extracting nucleic acids from untreated cellulose-based paper was applied to the RPA method for the detection of viruses in horticultural crops and fruit trees that we recently developed. The cellulose-based paper method can capture nucleic acids in less than 30 seconds very simply, overcoming the limitations of molecular diagnostics for field application, and can be utilized in a wide range of diagnostic applications inside and outside the laboratory environment.

P-07

목질계 바이오매스의 리그닌-탄수화물 복합체(Lignin-carbohydrate complex: LCC) 분리와 구조분석

신윤정[1,2], 조하영[1,2], 이재원[1,2]
[1]전남대학교 임산공학과
[2]IT-Bio 융합시스템전공

초록

화석연료의 광범위한 사용으로 에너지 고갈과 환경오염 문제가 대두되고 있다. 최근 화석연료 기반의 산업들이 탄소배출을 감소시킬 수 있는 친환경 산업으로 전환되고 있다. 목질계 바이오매스는 재생가능하고 친환경적인 중요한 소재 중 하나이다. 이들을 효율적으로 사용하기 위해서는 분해거동에 대한 이해가 선행되어야 한다. 목질계 바이오매스는 수종에 따라 다른 리그닌-탄수화물 복합체 구조를 형성한다. 이러한 리그닌-탄수화물 복합체 결합의 차이는 바이오매스의 전처리 및 효소가수분해에 영향을 미친다. 따라서, 본 연구에서는 수종에 따른 리그닌-탄수화물 복합체의 분석을 통하여 구조적 차이를 확인하고자 한다. 분석 시료는 침엽수(낙엽송, 소나무) 2종과 활엽수(참나무, 유칼립투스) 2종을 사용하였다. 리그닌-탄수화물 복합체 분리 방법으로는 선행연구에 따라서 DMSO/TBAH 처리 후 Ba(OH)2 처리하여 고형잔사와 가용 부분을 획득하는 방법으로 수행하였다. 바이오매스로부터 획득한 LCC1(Glucan-Lignin), LCC2(Glucomannan-Lignin), LCC3(Xylan-Lignin)의 구조분석을 수행하였다. 바이오매스의 LCC 분리 수율은 60~90%로 나타났고, LCC1, 2, 3의 비율은 수종에 따라 차이를 보였다. X선 회절 분석으로 LCC 분획의 결정성 영역은 낮게 나타났고, 퓨리에 변환 적외선 분광법을 통해 1423 cm-1에서 리그닌관련 피크의 변화가 나타났다. 또한, 핵자기공명 분석을 통해 수종에 따른 구조적인 차이를 확인하였다.

감사의 글

이 논문은 2021년도 정부(과학기술정보통신부)의 재원으로 한국연구재단의 지원을 받아 수행된 연구임(No. 2021R1A2C100719912).

P-08

연속식 물리적/열수 전처리에 의한 바이오매스 특성분석

조하영[1,2], 신윤정[1,2], 이재원[1,2]
[1]임산공학과 전남대학교
[2]IT-Bio 융합시스템전공 전남대학교

초록

목질계 바이오매스를 바이오에너지로 이용하기 위해서는 전처리 공정이 필요하다. 바이오매스 전처리 방법으로 산, 알칼리, 유기용매를 사용한 화학적 전처리가 주로 사용되었다. 하지만 화학적 전처리로 인해 환경오염 문제가 발생하여 이를 해결하기 위한 친환경적인 전처리 방법이 필요하다. 본 연구에서는 미이용 임목부산물을 사용하여 물리적 전처리를 수행한 후 열수 전처리를 진행하였다. 구조분석은 성분분석, XRD 및 FTIR을 수행하였다. 볼밀 전처리 후 바이오매스의 셀룰로오스Ⅰ 구조가 파괴되었음을 확인하였다. 하지만 초음파 전처리 바이오매스는 시간이 증가함에 따라 결정화도가 증가하였다.

감사의 글

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P-09

대체감미료를 이용한 저칼로리 콤부차 제조 및 특성

장다은[1*], 이하늘[2], 홍성진[1], 정아영[3], 김영민[2]

[1]전남대학교 융합식품바이오공학과

[2]전남대학교 식품공학과, [3]전남농업기술원 차산업연구소

초록

콤부차(Kombucha)는 효모와 초산균 등을 포함한 스코비(SCOBY)와 홍차 또는 녹차를 우려낸 추출물과 당을 첨가해 발효한 음료이다. 설탕 등의 당이 발효에 있어 중요한 요소이나 당 함량에 따라 칼로리가 높아질 수 있다는 문제점을 수반한다.

본 연구에서는 저칼로리 콤부차 제조를 목적으로 비정제 원당의 함량을 달리한 대체감미료(난소화성 말토덱스트린, 효소처리 스테비아, 수크랄로스)를 첨가한 콤부차를 제조하여 콤부차 발효특성, 콤부차 내 생성된 유기산, 카테킨 및 카페인 함량변화를 측정하고, 음료 등의 식품소재로서의 특성을 조사하였다. 2주일 동안 발효를 통해 제조된 콤부차의 색도는 전반적으로 커다란 차이를 보이지 않았지만, pH는 초기 5.4에서 pH 2.81로 감소하였다. 모든 콤부차에서 acetic acid, citric acid, succinic acid는 공통적으로 측정되었고, 특이하게도 대체감미료를 첨가한 콤부차에서는 D-gluconic acid가 높게 확인되었다. 카테킨 함량은 발효기간 중 커다란 변화를 보이지 않았지만, 카페인은 발효 초기와 비교하면 5배 감소하였다.

따라서 본 연구에서는 기존 콤부차에 필수적인 설탕 함량을 낮추고 대체감미료를 첨가한 저칼로리 콤부차 개발이 가능하였고 새로운 저칼로리 건강발효 음료개발의 가능성을 제시하였다.

P-10

Lactobacillus plantarum GS100에서 유래한 β–glucosidase를 이용한 Rubusoside 생산

안혜수[1]*, 홍성진[1], 김영민[1]
[1]전남대학교 융합식품바이오공학과

초록

Rubusoside는 steviol glycoside로서 *Rubus suavissimus* S. Lee와 *Stevia rebaudiana* (Asteraceae) 등의 잎에 존재하는 희소당이다. 그러나, rubusoside의 생산 비용은 stevioside와 같은 다른 steviol glucoside보다 약 10배 이상이며 추출 및 정제에 대한 경제적 환경적 부담이 크다. 대부분 rubusoside는 stevioside를 β-glucosidase, β-galactosidase 또는 lactase 등의 생물전환을 이용 stevioside의 C-13 부위의 β-1,2 결합된 glucose를 분해하여 얻을 수 있다. 본 연구실의 선행연구를 통해 식품허용 유산균인 *Lactobacillus plantarum* GS100가 stevioside를 생물전환하여 rubusoside를 생산할 수 있음을 보고하였다. 본 연구에서는 rubusoside 생성능을 보인 유산균의 전체 유전자서열분석을 통해 2종의 β-glucosidase가 존재함을 확인하였고 두 유전자를 클로닝하여 IPTG유도에 의해 18℃에서 21시간 재조합 단백질을 생산하였다. 효소특성을 조사한 결과 2종 효소는 각각 rubusoside producing enzyme (RPase), steviol glucoside producing enzyme (SGPase)이라고 명명하였다. SGPase는 stevioside와 rebaudioside A로부터 주로 rubusoside, rebaudioside B를 생산하였다. 또한, RPase는 steviosde로부터 주로 rubusoside를 생산하였다. 본 연구를 통해 *L. plantarum* GS100에서 유래한 2종의 β-glucosidase 모두 stevioside로 부터 rubusoside를 생산하였고 향후 고감미 소재 및 가용화 소재를 대량생산이 가능하다는 것을 확인할 수 있었다.

P-11

추출조건별 물리·화학적 특성 및 항산화 활성을 통한 *Porphyra dentata* 유래 기능성 다당류의 최적 추출조건 확립

임현정[1]*, 이하늘[2], 조정용[2], 김영민[2]
[1]전남대학교 융합식품바이오공학과
[2]전남대학교 식품공학과

초록

김의 다당류는 3, 6-anhydro-*L*-galactose (*L*-AHG), 갈락토스 및 황산염으로 구성된 산성 갈락탄이다. 김의 기능성 다당류의 연구로는 *L*-AHG 및 황산염 함량과 관련하여 항산화 활성, 면역증강 기능 등이 보고되고 있다. 하지만 추출 용매에 따른 구성성분 차이 및 생체 활동 (Biological activity)에 대한 연구는 미비하다. 따라서, 본 연구에서는 잇바디돌김 (*Porphyra dentata*)을 소재로 하여 다양한 추출조건으로부터 *L*-AHG 및 황산염 함량을 조사하고, 그에 따른 항산화 활성을 평가하였다. 또한, 추출 용매별 최적의 추출조건으로 대량 추출하여 얻은 잇바디돌김 유래 다당류의 화학적 특성 및 항산화 활성을 비교·평가하여 최종적으로 기능성 다당류를 얻기 위한 최적의 추출 방법을 확립하였다. 잇바디돌김 유래 다당류는 3시간 동안 다양한 온도에서 물, 초음파, 산, 및 알칼리 추출을 통해 얻었다. 실험 결과, 전반적으로 산 추출법을 제외한 다른 추출법들에서는 온도가 낮을수록 *L*-AHG, 황산염 함량 및 분자량 크기가 높게 측정되었다. 항산화 활성은 *L*-AHG 및 황산염 함량이 증가함에 따라 활성이 높았다. 따라서 25℃, 3시간 추출조건에서 대량 추출하였으며, 구성성분 측정 결과 알칼리 추출법이 *L*-AHG 및 황산염 함량이 높았다. 또한, 항산화 측정 결과 알칼리 추출이 가장 높은 활성을 보였다. 결론적으로 본 연구에서 *L*-AHG 및 황산염이 많이 함유된 알칼리 추출법이 높은 항산화 활성을 갖는 기능성 다당류를 추출하는 최적의 추출법임을 시사한다.

P-12

목질계 바이오매스 기반 바이오차를 이용한 메틸렌블루 흡착과 탈착 특성 - 흡착모델 평가

이은주[1,2], 이재원[1,2]
[1]전남대학교 임산공학과
[2]IT-Bio 융합시스템전공

초록

급격한 산업발달로 발생되는 산업폐기물을 제거하기위한 친환경 방법이 필요하다. 기존에 염료폐수 처리는 높은 비용과 전문성이 요구되는 어려움이 있다. 바이오차를 이용한 흡착은 이를 해결할 수 있는 방법이다. 본 연구에서는 목질계 바이오매스 바이오차를 이용해 메틸렌블루(Methylene blue) 흡착 및 탈착 특성을 분석하고 흡착모델을 통해 흡착거동을 평가하고자 한다. 소나무와 유칼립투스로부터 방향족 구조의 바이오차를 형성하는 것을 확인하였다. BET 분석결과 소나무와 유칼립투스를 90분동안 탄화하였을 때 높은 비표면적(PR-C : 437.58 m^2/g ER-C : 389.73 m^2/g)을 나타냈다. 메틸렌블루 제거율은 소나무와 유칼립투스 바이오차 90분 조건으로 1 g 함유하였을 때 수용액상에서 완전히 제거되었다. 유칼립투스 90분의 경우 흡착 후 탈착하여 재사용 하였을 때 91%의 높은 제거율을 나타내어 메틸렌블루 제거에 적합한 소재라고 판단할 수 있다.

감사의 글

본 결과물은 농림축산식품부의 재원으로 농림식품기술기획평가(농업에너지 자립형 산업모델기술개발사업)의 지원을 받아 연구되었음(No.321004022HD030).

P-13

KOH 전처리 바이오매스로부터 제조된 바이오차의 물리 · 화학적 특성

송대연[1,2], 이재원[1,2]
[1]전남대학교 임산공학과
[2]IT-Bio 융합시스템전공

초록

본 연구에서는 참나무를 이용하여 KOH 0%, 2%, 4%로 전처리 하였다. KOH 농도가 증가함에 따라 전처리 수율은 95.14%에서 78.52%로 감소하였지만, 탄화 수율은 25.78%에서 31.10%로 증가하였다. KOH 농도가 증가함에 따라 바이오매스와 바이오차의 결정화도는 44.56%에서 55.99%와 7.91%에서 13.55%로 증가하였다. 바이오매스는 KOH 농도가 증가함에 따라 C=O에 해당하는 피크가 감소하여 헤미셀룰로오스와 리그닌의 감소를 확인할 수 있었으며, 바이오차의 경우 O-C-O, C=O에 해당하는 피크가 증가하여 산소 함유 작용기가 증가하였음을 확인하였다.

Keywords: Biochar, KOH, Pretreatment

감사의 글

본 결과물은 농림축산식품부의 재원으로 농림식품기술기획평가원(농업에너지자립형 산업모델기술개발사업)의 지원을 받아 연구되었음(No.321004022HD0 30).

P-14

Methane production potential of cow manure

So Yun Park[1], Seon Hee Kim[1], Eun Hea Jho[1]*

[1]Department of Agricultural and Biological Chemistry, Chonnam National University, Gwangju 61186 Republic of Korea

ABSTRACT

With increasing interest in climate change issues, there is an increasing need for research into techniques for reaching zero net emission of carbon. Animal manures are one of the biggest sources of greenhouse gases and improper disposal of animal wastes contribute to the increasing greenhouse gases in the atmosphere. In order to move towards the zero net emission of carbon, greenhouse gases generated from animal manures can be converted to energy. When the methane yield from animal manures can be improved, more energy can be generated from animal manures. In this study, the potential for methane production from cow manure was studied by measuring the methane yield using the biochemical methane potential (BMP) test. In particular, the effect of co-digestion using agricultural by-products such as rice straw on the methane production was studied. The methane yields from the co-digestion of cow manure and rice straw were relatively higher than that from the separate digestion of cow manure or rice straw. Among the co-digestion conditions studied, the average methane yield was greater when the cow manure and rice straw was mixed at 2:1 ratio. Overall, the results show the methane production potential from cow manure and rice straw and the needs for further studies to improve the methane yield from cow manures

P-15

Joint effect of microplastics and imidacloprid on lettuce

Md Mehedee Hasan[1], Eun Hea Jho[2]*

[1]Department of Agricultural Chemistry, Chonnam National University,

[2]Department of Agricultural and Biological Chemistry, Chonnam National University, Gwangju 61186 South Korea, Republic of Korea

ABSTRACT

Microplastics are introduced into the environment due to the use and disposal of plastic products. In addition, pesticide residues can also be detected on agricultural land due to the use of various pesticides. Lettuce (Lactuca sativa L.) is a widely cultivated, consumed and commercially important crop. In this study, we investigated the effect of low-density polyethylene (LDPE) microplastics and imidacloprid, one of the pesticides, on lettuce. After contaminating the soil with various concentrations of LDPE and imidacloprid, biomass and chlorophyll content of lettuce were measured to examine lettuce growth. The underground and ground growth of lettuce exposed to LDPE and imidacloprid simultaneously decreased compared to the control group. For example, in soil contaminated with 200 mg/kg of imidacloprid and 3% of LDPE, the growth of lettuce decreased by about 68% compared to the control group. In addition, the inhibitory effect increased as the concentration increased. For example, the chlorophyll content of lettuce grown in soil contaminated with 200 mg/kg of imidacloprid and 3% of LDPE decreased by about 53% compared to the control group, while lettuce grown in soil contaminated with 20 mg/kg of imidacloprid and 0.5% of LDPE decreased by about 41%. In addition, it was confirmed that imidacloprid was absorbed by lettuce leaves. These results mean that microplastics and pesticides in the soil can have a harmful effect on crop production such as lettuce. Therefore, further research is needed for proper management of residual pesticides and microplastics in agricultural land.

P-16

Melatonin regulates iron homeostasis by inducing hepcidin expression in hepatocytes

박우람
전남대학교 융합식품바이오공학과

ABSTRACT

The pineal hormone melatonin plays important roles in circadian rhythms and energy metabolism. The hepatic peptide hormone hepcidin regulates iron homeostasis by triggering the degradation of ferroportin (FPN), which transfers cellular iron to the blood. However, the role of melatonin in the transcriptional regulation of hepcidin is largely unknown. Here, we showed that melatonin upregulates hepcidin gene expression by enhancing melatonin receptor 1 (MT1)-mediated c-Jun N-terminal kinase (JNK) activation in hepatocytes. Interestingly, hepatic hepcidin and serum iron levels showed a circadian rhythm expression pattern. In addition, melatonin significantly induced hepcidin gene expression and secretion and subsequent FPN degradation in hepatocytes, which resulted in cellular iron accumulation. Melatonin-induced hepcidin expression was significantly decreased by the melatonin receptor antagonist luzindole and by the knockdown of MT1. Moreover, melatonin activated JNK signaling and upregulated hepcidin expression, both of which were significantly decreased by SP600125, a specific JNK inhibitor. Chromatin immunoprecipitation analysis showed that luzindole significantly blocked melatonin-induced c-Jun binding to the hepcidin promoter. Finally, melatonin induced hepcidin expression and secretion by activating the JNK-c-Jun pathway in mice, which were reversed by luzindole treatment. These findings reveal a previously unrecognized role of melatonin in the circadian regulation of hepcidin expression and iron homeostasis.

P-17

Nuclear receptor ERR modulates antimicrobial peptide expression for host innate immunity in *Tribolium castaneum*

최병윤
전남대학교 융합식품바이오공학과

ABSTRACT

Antimicrobial peptides (AMPs) are core components of innate immunity to protect insects against microbial infection. Nuclear receptors (NRs) are ligand-dependent transcription factors that can regulate the expression of genes critical for insect development including molting and metamorphosis. Here, we investigated the role of estrogen-related receptor (ERR), an insect ortholog of the mammalian ERR family of NRs, in transcriptional regulation of AMP genes for innate immune response of *Tribolium castaneum* (*T. castaneum*). Tribolium ERR (TcERR) expression was induced by immune deficiency (IMD)-Relish signaling in response to infection by Escherichia coli (E. coli), a Gram-negative bacterium, as demonstrated in TcIMD-deficient beetles. Genome-wide transcriptome analysis of TcERR-deficient old larvae using RNA-sequencing analysis showed that TcERR expression was positively correlated with gene transcription levels of AMPs including attacins, defensins, and coleoptericin. Moreover, TcERR could directly bind to ERR-response elements on the promoter of genes encoding defensin3 and coleoptericin, critical for innate immune response of T. castaneum. Finally, TcERR-deficient old larvae infected with E. coli displayed enhanced bacterial load by reducing E. coli-mediated mRNA expression of defensin3 and coleoptericin, resulting in a significantly less host survival. These findings suggest that TcERR coordinates transcriptional regulation of AMPs and host innate immune response to bacterial infection.

P-18

Effects of Controlling the Number of Sprouts on Stand Growth of Oak Forest after Sprout Regeneration

Du Hee Lee[1], Handoo Shin[1], Hyun-Jun Kim[1]

[1]Department of Forest Resources, Chonnam National University

ABSTRACT

This study was conducted to analyze the effect of controlling number of sprouts on stand growth of oak forest. The study site was located in Jangheung, Jeollanam-do, and three treatments(two, three and four sprouts per stump) were established in March 2019. Each treatment consisted of 12 plots(10 × 10 m), the root collar diameter (RCD) and height (H) of the sprouts were measured in March and October 2020 and October 2021. During the observation period, there was no significant difference in the mean growth of RCD and H of sprouts among three treatments. However, the stand volume of the 4-sprouting treatment plot showed a significantly higher growth than that of the others ($P < 0.001$). In the early growth stage, the stand volume per hectare increased with increasing the number of sprouts per stump. Even though the height growth had no significant difference among the treatments, the gap of height growth between each other has been increasing gradually. These study results indicate that increasing number of sprouts per stump will move up potential economic value of oak forests. Also, long-term observation is necessary for more accurate analyzation of growth trend of oak forest after sprout regeneration.

감사의 글

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P-19

Analysis of Changes in Organic Layer Accumulation in *Chamaecyparis obtusa* Forests according to Thinning Intensity

An-Hee Yang[1], Hyun-Jun Kim[1]

[1]Department of Forest Resources, Chonnam National University

ABSTRACT

This study was conducted to analyze the change in organic layer accumulation according to thinning intensity in *Chamaecyparis obtusa* Forests. The study site was consisted of 5 treatment zones, and the thinning rates were 30% for light thinning (LT), 40% for normal thinning (NT), 50% for heavy thinning (HT), and 60% for super-heavy thinning (SHT). The annual amount of fallen leaves in control(5,919 kg/ha) was significantly higher than those of LT (3,312 kg/ha), NT (3,562 kg/ha), HT (3,188 kg/ha), and SHT (4,169 kg/ha). As a result of calculating the organic decomposition rate by the model of Olson (1963), the decomposition constant (K) in Control (0.698) was lower than those of LT (1.019), NT (1.134), HT (1.130) and SHT (1.118). Therefore thinning may accelerate the decomposition rate of the organic layer. The steady-state organic accumulation in control was shown as 17,900 kg/ha, and was significantly higher than those of LT (15,700 kg/ha), NT (14,300 kg/ha), HT (9,900 kg/ha), and SHT (7,300 kg/ha). As a result of this study, thinning has the effect of reducing organic accumulation with the inflow decrease and the outflow increase.

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P-20

Decentralized Control of Field Robot Teams: Framework and Implementation

설재휘
전남대학교 융합바이오시스템기계공학과

ABSTRACT

The control of large-scale dynamic systems, such as field robots, requires a more modular and scalable approach than that offered by classic classical control theory. Therefore, an event-driven system based on supervisory control theory was introduced to overcome these limitations. Recently, we designed modular supervisory controllers for field robots in agricultural applications based on an event-driven system that combines time-driven and event-driven dynamics considering controllability and observability. However, because the dynamic system is more complicated, a more extended control system is required. Therefore, we propose a high-level, supervisor-based hierarchical control architecture by applying a decentralized supervisory control theory. The dynamics of heterogeneous field robot teams are modeled via a formal method called finitestate automata, and the behavior specifications are designed to express the control objectives for cooperation. Additionally, modular and hierarchical supervisors, which are more scalable and maintainable than the centralized supervisory controller, were synthesized. The proposed decentralized control framework was implemented, validated, and evaluated for performance via field tests. The experimental results confirmed that the robot team satisfied the given specifications and presented systematic results, and thereby validating the efficiency of the proposed control architecture.

P-21

Modeling and Control of Multi-UAV System for Tributary Mapping based on Hybrid Automata

설재휘
전남대학교 융합바이오시스템기계공학과

ABSTRACT

Tributary is the situation changes each time depending on environmental factor (e.g., weather) and the work must be performed and managed in an unstructured environment. For these reasons, unmanned aerial vehicles (UAVs) are utilized for tributary management with remote sensing. However, a single UAV cannot ensure enough coverage area for a large-scale tributary. To overcome this, it can be extended to multiple UAV systems, will increase the control complexity. In multi-UAV systems, classical control theory based on differential equations has some limitations in handling largescale complex dynamics systems. Other modeling methods and control theory should be introduced instead of traditional control theory. Therefore, this study proposes a multi-UAV system which is modelled hybrid automata method and controlled supervisory controller for tributary mapping. The proposed multi-UAV system was validated in dynamic simulators and showed that multi-UAV satisfy the behavior specifications. The supervisor proposed in this study was validated using a physics-based simulator.

P-22

An Origami-inspired Suction Cup of Robotic Gripper for Autonomous Cucumber Harvesting

Yuseung Jo[1, 2], Yonghyun Park[1, 2], and Hyoung Il Son[1, 2, *]

[1]Department of Convergence Biosystems Engineering, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, 61186, Republic of Korea

[2]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, 61186, Republic of Korea

ABSTRACT

In this paper, we propose a suction cup of a robotic gripper for cucumber harvesting. For the gripper of the robotic harvesting system, cutting, which is an essential specification, and grasping, which aids the stable cutting, are required. In a previous study, we proposed a gripper that satisfies both specifications and can respond to various crops. However, to expand the robotic gripper with cucumber, grasping specifications must be satisfied and that is a challenge with a general cone-type suction cup. To satisfy the requirement, we designed a cucumber specific suction cup that is optimized for the curvature of the cucumber simplified into a cylinder. According to the conventional modeling method, the suction is designed to maximize the effective radius. Cucumber, the target vegetable, is a rod-shaped vegetable in the form of a cylinder. Accordingly, to maximize the effective radius of the suction cup, we used a method of projecting a cone-type suction onto a cylinder which is simplified cucumber. However, to reduce the uncertainty of the actual robotic harvesting, cucumber simplifying is insufficient. To respond with the atypical curvature of cucumbers, we apply a foldable origami structure to the suction cup. For rigorous analysis of the proposed suction cup, the load-carrying capability is predicted through the modeling of suction and compared with the actual value. To validate the suction cup for cucumbers and various fruits(e.g., tomato, paprika), we measured 6 DOF force and torque by attaching onto rod-and sphere-shaped objects. The results exhibit the proposed suction perform appropriately to grasp various crops. We believe the results and analysis will help to design a suction cup that is more appropriate for cucumber harvesting.

P-23

Human-centered Method of Harvesting Robot System: Gripper, Harvest Ordering, and Visual Servoing

Yonghyun Park[1, 2], Jaehwi Seol[1, 2], Jeonghyeon Pak[1, 2], Yuseung Jo[1, 2], Changjo Kim[1], and Hyoung Il Son[1, 2, *]

[1]Department of Convergence Biosystems Engineering, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, 61186, Republic of Korea

[2]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, 61186, Republic of Korea

ABSTRACT

Recently, more farmers have introduced large-scale smart farms to increase fruits and vegetables production. Accordingly, research on robots for reducing labor and efficient harvesting is active. However, commercialized robots are rare because they are far below the yield of human work. Therefore, developing fast, accurate, and efficient robot technology is necessary. This paper proposed an effective fruits and vegetables harvesting robot with genetic algorithm-based harvest ordering and visual servoing. The proposed system was constructed by inspired the human-centered harvest method. In the harvesting method, (1) the genetic algorithm-based harvest ordering is planned, and (2) the manipulator is controlled in real-time even when the peduncle shakes through visual servoing, and the end-effector is moved to the cutting position. Set up a testbed similar to the actual environment, and an experiment was conducted. The harvest ordering plan took 25 seconds to approach the four fruits and vegetables in order. Because repeating the approach from a random location to fruits and vegetables ten times with visual servoing, errors of -2.81 mm and 10.95 mm were recorded on the image plane (u, v).

P-24

3D Bioprinting Assembly System For Volumetric Tissue in Centimeter-Scale

S. J. Kim[1], M. G. Kim[1], S. W. Kang[1], Y. E. Song[2], B. K. Kim[2], D. J. Lee[2] , S. H. An[3], S. W. Cho[3] and H. G. Yi[1,4, †]

[1] Department of Rural and Biosystems Engineering, CALS, Chonnam National University(CNU), 77 Yongbong-ro, Gwangju 61186, Republic of Korea

[2] Department of Polymer Science and Engineering, CNU, 77 Yongbong-ro, Gwangju 61186, Republic of Korea

[3] Department of Biotechnology, Yonsei University, 50 Yonsei-ro, Seoul 03722, Republic of Korea

[4] Department of Convergence Biosystems Engineering, CALS, CNU, 77 Yongbong-ro, Gwangju 61186, Republic of Korea

ABSTRACT

There is a major health crisis today in terms of the shortage of organs. Currently, there are thousands of people on transplant lists waiting for critical organs such as livers, kidneys, and hearts that could save their lives. Unfortunately, there are not nearly enough donor organs available to fill that demand. Thus, 3D bioprinting technology has been actively developed to create engineered tissues. However, replicating the complex biochemical environment of a major organ with actual human size remains a big challenge. Recently, ascidians-derived biomaterials have received great attention, owing to their extraordinary properties such as strong underwater adhesion and rapid self-regeneration. In this study, by using the adhesive property of pyrogallol-decorated hyaluronic acid (HA-PG), adhesion-assisted bioprinting process is developed for assembly of small-sized tissue modules to build a large-volume organ. Specifically, HA-PG was used as a glue to combine two 3D printed tissue modules to construct large-scale engineered tissues. Furthermore, by controlling the concentration of HA-PG, we can successfully print in desired location and viscosity. Now, we expect that our approach has significant potential in fabricating large-volume organs for application in the field of tissue engineering.

P-25

Emergence of multiple *Diaporthe* species causing kiwifruit rot and occurrence of resistance to a methyl benzimidazole carbamate fungicide in South Korea

Byeong Hak Jeong[1], Jihye Song[1], Seungeun Gi[1], Wonyong Kim[2] and Kwang-Yeol Yang[1]

[1]Department of Applied Biology, College of Agriculture and Life Sciences, Chonnam National University, Gwangju, 61186, South Korea

[2]orean Lichen Research Institute, Sunchon National University, Suncheon, 57922, South Korea

ABSTRACT

This study is the first report of a postharvest kiwifruit rot in South Korea caused by *Diaporthe eres* and related fungal pathogens. After single spore isolation of *Diaporthe*-like fungi isolated from rotten kiwifruits, isolates were identified based on the multi-locus phylogeny using the nuclear rDNA internal transcribed spacer and three nuclear protein-coding loci. Among the 41 single-spore isolates, a majority of the isolates (75%) were identified as *D. eres*, followed by *D. unshiuensis*, *D. phaseolorum*, *D.* cf. *pseudomangiferae* and *D. caryae*. We evaluated fungicide resistance of the 41 isolates and confirmed that a significant fraction of the isolates (15%) was resistant to thiophanate-methyl, raising a concern on overuse of this type of fungicide in kiwi orchards. By sequencing a region of *β*-tubulin gene, we identified two point mutations altering amino acid sequences correlated with the observed resistance. For effective diagnosis of incidence of the fungicide resistance in the fields, we developed allele-specific PCR analyses detecting the point mutations that confer reduced sensitivity to thiophanate-methyl. Genetic structure of the 41 isolates suggested that there were at least five independent mutational events for acquiring the fungicide resistance. Unexpectedly, there was no clear distinction in the genetic structure between the 41 kiwifruit isolates and Chinese isolates that caused grapevine dieback disease, suggesting these *Diaporthe* species are non-host-selective pathogens that could damage different horticultural crops of economic importance. This study will help develop a discerned protection program to cope with the ongoing and upcoming threats of these genetically diverse kiwifruit rot pathogens.

P-26

A maize phospholipase A1 homolog produces *in planta* haploid seeds

Jin Hoon Jang[1,2], Hae Seong Seo[1,2], Jae Hyun Lee[1,2], Chul Min Kim[3], Soon Ju Park[4], Jeong Hwan Lee[5], Yu-Jin Kim[6] and Ok Ran Lee[1,2*]

[1] Department of Applied Plant Science, College of Agriculture and Life Science, Chonnam National University, Gwangju 61186, Republic of Korea
[2] Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju 61186, Republic of Korea
[3] Division of Horticulture Industry, Wonkwang University, Iksan, 54538, Republic of Korea
[4] Division of Biological Sciences and Research Institute for Basic Science, Wonkwang University, Iksan, 54538, Republic of Korea
[5] Division of Life Sciences, Jeonbuk National University, Jeonju, 54896, Republic of Korea
[6] Department of Life Science and Environmental Biochemistry, Pusan National University, Miryang, 50463, Republic of Korea

ABSTRACT

Doubled haploid system can notably reduce the time required to create pure homozygous lines. The *in vitro* haploid induction system has long been used to produce haploid embryos using maternal or paternal germlines. Tissue culture-based *in vitro* methods are labor-intensive and genotype-dependent. However, a seed-based *in planta* haploid embryo induction system can overcome the limitations of the *in vitro* methods. Thus far, two main types of *in planta* haploid-inducing lines that trigger either paternal or maternal haploid embryos through seeds have been reported. One of them is the centromeric histone 3 variant (CENH3)-based induction system, in which the modification of a CENH3 allows the creation of haploid inducer lines that generate viable seeds containing a paternal haploid genome. The other is the monocot-specific maternal haploid induction system, which is based on the mutation of *ZmPHOSPHOLIPASE-A1*/*MATRILINEAL*/*NOT LIKE DAD* (*ZmPLA1*/*MTL*/*NLD*). The *ZmPLA1*-based haploid induction system is reported to produce viable seeds that contain a maternal haploid genome in only monocotyledonous plants such as maize, rice, wheat, and foxtail millet. The production of haploid seeds by genetic modification of *ZmPLA1* homologs in dicotyledonous has not yet been reported. Herein, we report that a novel *ZmPLA1* homolog is actively involved in the haploid embryo induction through seeds in *Arabidopsis* and rice. This discovery demonstrates that the seed-based *in planta* haploid induction system through genetic manipulation of *ZmPLA1* homologs can be applied to both dicotyledonous and monocotyledonous plants.

P-27

Factors of Soil Moisture on Potted plant Quality and Life in Distribution *Kalanchoe blossfeldiana* 'Discodip'

Se Young Lee, Ju Hwi Kim, Young Boon Lee*

Department of Horticulture, Chonnam National University, Gwangju, 6118, Korea

ABSTRACT

This study investigated the morphological and physiological factors by soil moisture on quality and shelf life in the distribution of *Kalanchoe blossfeldiana* 'Discodip'. The soil moisture treatments of the potted plant were high (> 80%) and low (< 40%). The physiological factors analyzed chlorophyll contents, chlorophyll fluorescence, and stomatal size change rate. As a result, there is no significant difference in shelf life, but high humidity (28.3 days) was 0.9 days higher than low humidity (27.4 days). The fresh weight and dry weight of the root, the number of flowers, and the flowering rate were significantly higher in the high humidity. Chlorophyll contents, chlorophyll fluorescence, and stomatal size change rate were numerically more elevated in the high humidity. In conclusion, the fresh weight and dry weight of the root, the number of flowers, the flowering rate, chlorophyll content, chlorophyll fluorescence, and stomatal size change rate were numerically higher than the low humidity in distribution.

P-28

Biocompatible Gelatin Nanoparticle as a Versatile Tool for Improving Plant Growth and Pesticide Effect

Sunho Park[1, 2, 3], Yonghyun Gwon[1, 2, 3], Woochan Kim[1, 2, 3], and Jangho Kim[1, 2, 3, *]

[1]Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea
[2]Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea
[3]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju, 61186, Republic of Korea

ABSTRACT

It is an important challenge to control and improve plant growth and pesticide effect in agriculture, and nanomaterials as novel strategy have been used to achieve these challenges. However, it is usually recognized that nanomaterials including carbon- and metal-based nanomaterials might influence toxicity in plant growth and does cause environmental pollution. In this study, we propose biocompatible gelatin nanoparticles (GNPs) as versatile tool to improve plant growth and pesticide effect. Based on unique properties of GNPs (e.g., very tiny size, surface charge, and loading capacity), it can be easily attached to plant leaves regardless of surface properties, and the agrochemical materials with GNPs can maintain their effect on the surface of plant leaves for longer. In addition, GNPs does not prevent the adsorption of nutrients on the root surfaces, and it can promote the plant growth. In addition, agrichemical materials-loaded GNPs can induce the insecticidal and weed-killing effects by maintaining pesticide effect in vitro and in vivo. These findings demonstrate the potential of GNPs in the real agricultural fields, and the proposed GNPs might be used for future sustainable agriculture.

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P-29

Eggshell Membrane-incorporated Cell Friendly Tough Hydrogels with Ultra-Adhesive Property for Biomedical Applications

Yonghyun Gwon[1, 2, 3], Sunho Park[1, 2, 3], Woochan Kim[1, 2, 3], Hyoseong Kim[1, 2, 3], and Jangho Kim[1, 2, 3, *]

[1]Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea

[2]Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea

[3]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju, 61186, Republic of Korea

ABSTRACT

Adhesive and tough hydrogels have received increased attention for their potential biomedical applications. However, traditional hydrogels have limited utility in tissue engineering because they tend to exhibit low biocompatibility, low adhesiveness, and poor mechanical properties. Herein, the use of the eggshell membrane (ESM) for developing tough, cell-friendly, and ultra-adhesive hydrogels is described. The ESM enhances the performance of the hydrogel network in three ways. First, its covalent cross-linking with the polyacrylamide and alginate chains strengthens the hydrogel network. Second, it provides functional groups, such as amine and carboxyl moieties, which are well known for enhancing the surface adhesion of biomaterials, thereby increasing the adhesiveness of the hydrogel. Third, it is a bioactive agent and improves cell adhesion and proliferation on the constructed scaffold. In conclusion, this study proposes the unique design of ESM-incorporated hydrogels with high toughness, cell-friendly, and ultra-adhesive properties for various biomedical engineering applications.

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P-30

Biodegradable and Flexible Nanoporous Films for Design and Fabrication of Active Food Packaging Systems

Woochan Kim[1, 2, 3], Taeseong Han[1, 2], Yonghyun Gwon[1, 2, 3], Sunho Park[1, 2, 3], Hyoseong Kim[1, 2, 3], and Jangho Kim[1, 2, 3, *]

[1]Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea

[2]Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea

[3]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju, 61186, Republic of Korea

ABSTRACT

Nanotechnology has facilitated the development of active food packaging systems with functions that could not be achieved by their traditional counterparts. Such smart and active systems can improve the shelf life of perishable products and overcome major bottlenecks associated with the fabrication of safe and environmentally friendly food packaging systems. Herein, we used a plasma-enabled surface modification strategy to fabricate biodegradable and flexible nanoporous polycaprolactone-based (FNP) films for food packaging systems. Their capacity for preserving tomatoes, tangerines, and bananas at room and refrigeration temperatures was tested by analyzing various fruit parameters (mold generation, appearance changes, freshness, weight loss, firmness, and total soluble solids contents). Compared with commonly used polyethylene terephthalate-based containers, the proposed system enhanced the fruit storage quality (i.e., retained appearance, reduced weight loss, better firmness, and sugar contents) by controlling moisture evaporation and inhibiting mold generation. Thus, the FNP film represents a new active food packaging strategy.

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P-31

Engineering Plant Growth and Development on Nanotopographical Cues

Mahpara Safdar[1, 2, 3], Sunho Park[1, 2, 3], Woochan Kim[1,2,3], Yonghyun Gwon[1, 2, 3], Yeon-Ok Kim[3], and Jangho Kim[1, 2, 3, *]

[1]Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[2]Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[3]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju 61186, Republic of Korea

ABSTRACT

Seed germination and root development are important indicators of plant development. Here, we propose a new nanotechnology to guide plant growth and development. We developed polymer-based soil model platforms with various nanotopographical features to explore the influence of guiding topographical cues on plant development including phenotypic aspects and gene regulation. The fabricated nanotextured surfaces showed the good mechanical stability, biocompatibility, strong adhesion, non-toxicity as well as super hydrophobicity. Our new Arabidopsis root system had the abundant molecular genetic resources according to the unique nano-structure designs, controlling the plant growth, which can be used as a new platform for investing the phenotype and gene networks. Finally, we showed some examples that our nanotopographical platforms could promote the plant growth and development by providing specific roadmap and transport genes responsible.

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P-32

Mitochodnrial *COI* sequence를 이용한 기후변화지표종 각시메뚜기 (*Patanga japonica* Bolívar, 1898)의 집단유전학 분석

표지영[1], 박정선[1], 김성수[2], 정헌천[3], 김익수[1,*]

[1]전남대학교 응용생물학과

[2]순천향대학교 한국자생동물자원활용융합연구소

[3]동아시아 환경생물연구소

초록

기후온난화에 따른 북위로의 서식처 확장과 이에 따른 집단의 유전적 다양성 변동 특징에 대한 이해는 장기적 측면의 한반도 생물다양성 이해를 위한 초석이라고 할 수 있다. 본 연구에서는 mitochondrial *COI* 유전자의 염기서열을 이용하여 우리나라 100종의 기후변화지표종 중 유일한 메뚜기목 곤충인 각시메뚜기(*Patanga japonica* Bolívar, 1898) 집단(제주도, 담양, 하동, 무안, 밀양, 평택, 영월 125개체)의 유전적 다양성, haplotype 계통, 집단구조 등에 대한 분석을 수행하였다. 그 결과, 북위로의 이동은 가장 빈도가 높은 haplotype만을 동반하며 haplotype 다양성이 감소하는 등 CORE 집단의 일부 유전적 다양성만을 동반하는 특징을 나타내었다. 이로써 북위의 양질 서식처 유무와 이에 따른 이동집단의 정착 및 활성이 각시메뚜기의 유전적 다양성 회복에 중요한 관건이 될 것으로 사료된다. 아울러 지놈기반의 연구를 통한 심도있는 결과 도출이 필요한 실정이다.

P-33

Development of diagnosis method for the Korea endemic silkworm strains of *Bombyx mori* (Lepidoptera: Bombycidae) using whole genome sequences

Jeong Sun Park[1], Min Jee Kim[1,2], Seong-Wan Kim[3], Kee-Young Kim[3], Seong-Ryul Kim[3], and Iksoo Kim[*,1]

[1]Department of Applied Biology, Chonnam National University, Republic of Korea
[2]Honam Regional Office, Animal and Plant Quarantine Agency, Republic of Korea
[3]Department of Agricultural Biology, Rural Development Administration, Republic of Korea

ABSTRACT

The endemic silkworm strains are important biological resources to breed new silkworm strains which have new traits. Silkworm strains are very difficult to distinguish due to the morphological similarity of larvae and adults. Thus, we developed molecular diagnosis method to distinguish five silkworm strains, which are endemic to Korea using whole genome sequences. The diagnosis method was developed using "Decision tree model" to distinguish each endemic strain from four endemic and 35 stock strains due to difficulty in applying one shot diagnosis method, caused by genetic similarity among silkworm strains. This method is reliable and efficient, so can be used to identify the five endemic silkworm strains, preserved in Korea.

P-34

Antioxidant Activity of Lyophilized Red Cabbage (*Brassica oleracea* L. var. *capitata f. rubra*) Water Soluble Extracts Treated by Various Carbohydrase Enzymes

Ji Won Park[1] and Koo Bok Chin[1]

[1]Department of Animal Science and bioindustry, Chonnam National University, Korea

ABSTRACT

This study was to investigate the antioxidant activities using red cabbage (RC) as affected by various 1% carbohydrase enzymes such as amylase, cellulase, and viscozyme. 2 parts of sodium acetate buffer were mixed with 1 part fresh RC at pH 5.0, which were incubated at 37°C. After centrifugation, the supernatant was lyophilized (RC extracts). The yield of the RC extract using viscozyme showed a higher yield than the extracts using amylase and cellulose (p<0.05). All enzyme-extracted treatment groups showed higher antioxidant activity than fresh RC. In total phenolic compound contents, the treatment group using amylase showed higher phenolic compound contents than CTL. Whereas no significant differences in antioxidant activity were observed among the enzyme-treated treatments. Based on this study, we suggest the possibility of RC extract as a novel natural antioxidant in meat products

P-35

Evaluation of Physicochemical and Texture Properties of Chicken Breast Sausages Containing Various Levels of Psyllium Husk Powder

Ji Seon Choi[1], Koo Bok Chin[1]

Department of Animal Science and Bioindustry, Chonnam National University, Gwangju, Republic of Korea [1]

ABSTRACT

This study was conducted to evaluate physicochemical and texture properties on chicken breast sausages containing various levels (0, 0.5, 1.0 and 1.5%) of Psyllium Husk powder (PHP, < 300 μm) levels (0, 0.5, 1.0 and 1.5%). Cooking loss (CL, %), pH, color, expressible moisture (EM, %), texture profile analysis (TPA) and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) were performed. CL and EM (%) reduced with increased level of PHP ($p<0.05$). There was no difference in the pH values among the PHP added treatments ($p>0.05$). The addition of PHP did not affect the redness and the yellowness ($p>0.05$), but it caused a decrease in the lightness ($p<0.05$). However, the addition of PHP didn't affect the TPA ($p>0.05$). The SDS-PAGE result showed that the myosin heavy chain band decreased and the biopolymers were formed with PHP concentration-dependent manner. Therefore, the addition of PHP into sausages improved the water holding capacity without defects of the meat products.

P-36

Physicochemical Properties And Tenderness Of Marinated Pork Loin Injected With Gold And Green Kiwi Extracts During Incubation Time

Ha Eun Kim[1], Koo Bok Chin[1]
[1]Department of Animal Science and Bioindustry, Chonnam National University, Gwangju, Republic of Korea

ABSTRACT

This study was performed to evaluate physicochemical properties and tenderness in pork loin injected with 10% and 20% gold and green kiwi extracts during incubation at 10℃ for 24 hrs. Gold kiwi (*Actinidia chinensis* var. *chinensis* 'Zesy002') and green kiwi (*Actinida deliciosa* var 'Hayward Green') were used in this study. After the gold and green kiwifruits were homogenized with 20 mM phosphate buffer (pH 6.5) and centrifuged at 10,000 x G for 15 min, the supernatant of kiwi mixture was taken and used for this experiment. Gold and Green kiwi extracts were injected at 10% and 20% of the original weight of the pork loin cuts, which were measured the physicochemical and textural properties during incubation at 10℃ for 24 hrs. Before cooking, pH and color (CIE L*, a*, b*) values, myofibrillar fragmentation index (MFI), solubility of peptides in trichloroacetic acid (TCA), and sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) were measured at 0, 4, 8, and 24 hrs of incubation at 10℃. After cooking, pH and color values, cooking loss (CL, %), Warner-Bratzler shear force (WBSF, kg/g) values, and scanning electron microscope (SEM) were measured. The whole experiment was performed three times and the statistical analysis was performed two-way analysis of variance (treatment * incubation times at 10oC) at a significant level of 0.05%. efore cooking, the pork loin cuts injected with kiwi extracts showed lower pH values than CTL, regardless of levels of addition. TCA solubility and MFI values of pork loin containing 10% of green kiwi extract were similar to those of pork loin injected with 20% of gold kiwi extract. When kiwi extract was injected into pork loin, the tenderness increased with the increased incubation time up to 24 hrs. These results were confirmed by decreased myosin heavy chain (MHC) band of the SDS-PAGE. After cooking, the pork loin cuts injected with kiwi extracts showed lower pH values than CTL, whereas the injection of kiwi extracts into pork loin did not affect the color of cooked pork loin. Regardless of the color of kiwi, pork loins injected with 20% kiwi extracts had a higher CL (%) than the CTL. A decrease in WBSV was observed when the kiwi extract was injected into pork loin, regardless of the level of addition. It can be confirmed that unlike the injected pork loin, control pork loin had well-organized and tightly arranged muscle reen kiwi had higher tenderizing ability than gold kiwi even when 10% injection was applied to pork loin. Although 20% injection improved tenderness of pork loin better than 10% injection, it might problems related to the increased CL. Thus, 10% injection of green kiwi extracts into pork loin might be recommended for use in meat as a tenderizing agent and for maintaining agent and maintaining the water holding capacity.

P-37

Evaluation of Different Levels of *Rhynchosia nulubilis* Powder on Product Quality of Low-fat Model Sausages

Min Jae Kim[1] and Koo Bok Chin[1]

[1]Department of Animal Science and Bioindustry, Chonnam National University, Gwangju, Republic of Korea

ABSTRACT

The objective of this study was performed to evaluate product quality of low-fat pork sausages (LFPS) added with various levels of *Rhynchosia nulubilis* powder (RNP). pH, color, proximate composition, expressible moisture (EM, %), cooking loss (CL, %), and textural profile analyses (TPA) were measured. LFPS were prepared with 5 treatments: 0, LFPS; 0.5, LFPS added with 0.5% RNP; 1.0, LFPS added with 1.0% RNP; 2.0, LFPS added with 2.0% RNP; 3.0, LFPS added with 3.0% RNP. No differences in pH value, fat content, and TPA except for hardness values were observed among all treatments($P>0.05$). Addition at 3.0% was lower lightness and redness values than 0%($P<0.05$). However, yellowness values increased with increased levels of RNP into LFPS($P<0.05$). Moisture content was lower at the addition of 3.0% those at 1.0%. Whereas protein content was higher at 3.0% addition as compared to the lower levels($P<0.05$). EM (%) and CL (%) of 3.0% were higher than those of LFPS at 0%. LFPS at 1.0% was the lowest hardness among all treatments($P<0.05$). Thus, the addition of 0.5% to LFPS was similar to those with CTL, and it might improve the functionality such as antioxidant activity.

P-38

Analysis of the Effects of Thinning on Soil Respiration in *Chamaecyparis obtusa* Forests

Jeong-Gwan Lee[1], Du-Hee Lee[1], Do-Hyun Ryu[1], Dae-Hyuck Cho[1], Hyun-Jun Kim[1]
[1]Department of Forest Resources, Chonnam National University

ABSTRACT

The study was conducted to analyze soil respiration according to thinning intensity for *chamaecyparis obtusa* forests. The study site was made up of 5 treatment zones: no treatment (Con), light thinning (LT), normal thinning (NT), heavy thinning (HT), and super heavy thinning (SHT). Thinning was carried out in 2000 and 2018, and the thinning rate was 30% for LT, 40% for NT, 50% for HT, 60% for SHT. The soil respiration volume was measured once a month from January to December 2019, using a portable soil respiration machine(GMP343, Vaisala, Finland), randomly selected three measurement points within each plot. The soil respiration volume tended to increase in both Con and treatment zones during summer and decrease in winter. Among them, soil respiration volume was the highest in August(Con 8.25 gCO_2 m^{-2} day^{-1}, LT 12.37 gCO_2 m^{-2} day^{-1}, NT 18.86 gCO_2 m^{-2} day^{-1}, HT 20.93 gCO_2 m^{-2} day^{-1}, SHT 19.96 gCO_2 m^{-2} day^{-1}). Thus, it is believed that the rise of temperature accelerates soil respiration. The soil respiration volume between Con and treatment zones showed significantly differences from April to October, when the monthly average temperature was more than 10℃(P < 0.05). The soil respiration volume from April to October showing significance by treatment zone was the lowest in Con. LT was the lowest in May. Also, the soil respiration volume between Con and LT did not show a significant result. Thus, it is judged that soil respiration increases significantly when the thinning rate is over 40%.

Key words: *Chamaecyparis obtusa*, thinning, soil respiration

감사의 글

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P-39

Evaluation of rumen microbiome of early fattening Hanwoo steers with different feed efficiencies

Park CJ[1], Lee HS[1,2], Yoon S[1], Sim SH[1], Seon HS[1], Kim MS[1], Jung SG[1], Kim M[1]

[1]Division of Animal Science, College of Agriculture and Life Sciences, Chonnam National University, Gwangju, Korea

[2]Graduate School of Agricultural Science, Tohoku University, Sendai, Japan

ABSTRACT

The objective of this study is to evaluate the rumen microbiome of early fattening Hanwoo steers with different feed efficiencies. Sixty-four Hanwoo steers were fed the same TMR diet containing 13.4% CP, 5.2% EE, 51.1% NDF and 25.9% ADF. Among the 64 steers, 12 steers including the top 10% feed efficiency group (n=6) and the bottom 10% feed efficiency group (n=6) were selected. From the 12 steers, fresh rumen fluid samples were collected using the stomach tubing method and then subjected to metagenomic DNA extraction using the bead-beating method. The 16S rRNA gene amplicon sequencing on the MiSeq platform was conducted and then rumen microbiome was analyzed using the QIIME2 software package and the MicrobiomeAnalyst tool. Alpha diversity indices did not differ between the two groups whereas the principal coordinate analysis showed overall different microbiome between the two groups. LEfSe showed that *Anaerovibrio* was more abundant (p < 0.05) in the top 10% group than in the bottom 10% group. At the species level, *Prevotella bryantii* and *Selenomonas ruminantium* were more abundant (p < 0.05) in the top 10% group than in the bottom 10% group. Overall functional genetic profiles were different between the top 10% and the bottom 10% groups (p < 0.05). This study indicates that rumen microbiome of early fattening Hanwoo steers is associated with feed efficiency, and some taxa may serve as potential biomarkers representing high feed efficiency.

P-40

Difference of Grassland Biomass in Gangwon-do and Jeju-do

Min-Seo Kim[1], Sle-gee Lee[2], Hyun-Jun Kim[1]

[1]Department of Forest Resources, Chonnam National University,
[2]Fprest Resource Research Center, Chonnam National University

ABSTRACT

This study was conducted to analyze the difference of grassland biomass between Gangwon (GW) and Jeju(JJ) provinces. Eight sites in GW and six sites in JJ were selected, and the aboveground and belowground parts of biomass were collected. Biomass was weighted after dried in oven. Of GW grassland, the aboveground biomass was 3.67±0.20 $Mg \cdot ha^{-1}$, and the belowground biomass was 16.13±2.43 $Mg \cdot ha^{-1}$. The aboveground and belowground biomass of JJ grassland were 8.26±0.74 and 5.30±0.75 $Mg \cdot ha^{-1}$, respectively. The aboveground biomass of GW grassland was significantly lower than that of JJ grassland, whereas, the underground biomass of GW grassland was significantly higher than that of JJ grassland. GW has northern temperature and LAC, but JJ has warm temperate・subtropical climate and volcanic ash. From this reason, the above-ground biomass growth of JJ grassland with high organic matter content higher than that of GW grassland. However, root growth was inhibited by high site quality and soil moisture in JJ grassland. Thus, the results of this study indicated that the different climate zone and soil type have the effects on the grassland growth.

P-41

Downregulation of ADAMTS3 Suppresses Stemness and Tumorigenicity in Glioma Stem Cell

Hyun-Jin Kim[1], Sung-Hak Kim[1,*]

[1]Laboratory of Animal Molecular Biochemistry, Chonnam National University, Gwangju 61186, Republic of Korea

[*]Corresponding author

ABSTRACT

Aims: Glioblastoma multiforme (GBM) is the most aggressive type of human brain tumor, with a poor prognosis and a median overall survival of fewer than 15 months. Glioma stem cells (GSCs) have recently been identified as a key player in tumor initiation and therapeutic resistance in GBM. ADAMTS family of metalloproteinases is known to cleave a wide range of extracellular matrix substrates and has been linked to tissue remodeling events in tumor development. Here, we investigate that ADAMTS3 regulates GSC proliferation and self-renewal activities, and tumorigenesis in orthotopic xenograft models.

Methods: ADAMTS3 mRNA expression levels in normal human astrocyte (NHA), glioma, and GSCs cell lines were compared. After knockdown of ADAMTS3, alamarBlue assay, in vitro limiting dilution, and orthotopic xenograft assays were performed. To investigate the tumor-associated roles of ADAMTS3, several statistical assays were conducted using publicly available datasets.

Results: ADAMTS3 level was remarkably higher in GSCs than in NHA, glioma cell lines, and their matched differentiated tumor cells. Interestingly, knockdown of ADAMTS3 disrupted GSC's proliferation, self-renewal activity, and tumor formation in vivo. Furthermore, ADAMTS3 could be used as an independent predictor of malignancy progression in GBM.

Conclusion: We identified ADAMTS3 as a potential therapeutic target for GBM.

P-42

The establishment of a pepper transformation system for the application of Virus-included gene editing

Min-su Kim[1], Tripathi Sharanya[1], Da-min Choi[1], Yun-jeong Han[2], Jeong-il Kim[1,2*]

[1]Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju, 61186
[2]Kumho Life Science Laboratory, Chonnam National University, Gwangju, 61186

ABSTRACT

Chili peppers are one of the most economically valuable crops, but they are known to be difficult to transform, so they have limitations in researching gene functions and applying gene correction technologies compared to other crops. One of the ways to overcome this is virus-induced gene editing (VIGE) technology, which can be used to perform gene correction of peppers without additional tissue culture, which is expected to enable the identification of the functions of various useful genes in peppers and the development of breeding materials. In this project, we intend to secure an egg cell-specific promoter of peppers to produce a vector expressing Cas9 and produce an egg cell-specific Cas9 overexpressing pepper transformer for the application of VIGE technology. To this end, research is being conducted to establish an agrobacterium-mediated pepper transformation system by securing various commercial varieties of peppers first. A total of 18 chili peppers are currently in use, including two commercial inbred lines (C15 and P915) sold by Nongwoo Bio Co., Ltd., 10 systems (PE-2101 to PE-2110) sold by Jenong S&T, and six systems (Bu-Nseries) provided by the project.

In addition, about 10 systems were acquired from the Seoul National University core collection and will be used for future experiments. Summarizing the results of the studies conducted so far, the conditions and efficiency of plant re-differentiation using hypocotyl and cotyledon obtained from a total of 18 kinds of red pepper seeds were verified. Since then, the transformed plant has been selected through kanamycin or hygromycin resistance along with the investigation of agrobacterium-mediated transformation conditions. The results so far showed that Nongwoo Bio's line was more likely to succeed in transformation than Jenong S&T's systems, and in the case of the system received by the project, two out of six types (Bu-ND21101 & D21102) were found to have excellent reactivity. The poster below summarizes the research results obtained using the 18 kinds of red pepper seeds.

P-43

Fabrication of Perfusable and Free-form In vitro Vascular Model Using a Coaxial Nozzle

M.G Kim[1], S.J Kim[1], S.W Kang[1], S.Y Kim[1], S.G Nam[1], Hee-Gyeong Yi[1,2,†]

[1]Department of Rural and Biosystems Engineering, CALS, CNU, 77 Yongbong-ro, Gwangju 61186, Republic of Korea
[2]Department of Convergence Biosystems Engineering, CALS, CNU, 77 Yongbong-ro, Gwangju 61186, Republic of Korea
†Corresponding author(hgyi@jnu.ac.kr)

ABSTRACT

Conventional manufacturing techniques of an in vitro blood vessel model(BVM) using tissue engineering differ distinctively from native vessels in both physiological and morphological terms. As the conventional BVM has only been manufactured by two-dimensional (2D) fabrication methods, limitations remain in synthesizing the multi-layered structure of the blood vessel or managing the various diameters and curves.

To overcome such limitations, three-dimensional (3D) bioprinting technology, a computer-based additive manufacturing method, appears as the best candidate for synthesizing delicate vessels of various diameters of relatively free-forms. Not only able to imitate an actual blood vessel's microenvironment, 3D bioprinting technology also enables anatomical and clinical applications, through the fabrication of an in vitro model tailored to each patient.

While different bioprinting methods to fabricate BVM have been developed, a free-form blood vessel platform utilizing coaxial nozzle-based bioprinting was proposed by Gao et al. [1]. The coaxial nozzle extrudes two materials simultaneously and concurrently prints out in concentric circle form to fabricate the desired shapes. Our project consists in applying this coaxial nozzle-based bioprinting to establish the printing process of in vitro models of various shapes. The perfusable hollow tubular structure was fabricated using a sacrificial bioink in the core part and verified perfusion performance by diffusing fluorescence beads. This research focuses on developing a potential in vitro model in which tissues and blood vessels are interconnected through a perfusable blood vessel.

P-44

The provision of the sling belt as a nesting material in farrowing crates: their effects on sow prepartum behavior

Jeon HL[1], Kim YH[1], Lee JH[1], Kim JS[1], Choi HI[1] Kang KW[2], Kang JW[2] and Yun J[1]

[1]Department of Animal Science, Chonnam National University, Gwangju, Korea

[2]Swine Research Center, Sunjin R&D Institute, Sunjin Co., Ltd., Korea

ABSTRACT

Prepartum nest-building behavior of sows plays an essential role in farrowing and lactating performance. However, due to lack of space, materials, or both, the sows confined in the crating system have restrictions on such behavioral expressions, leading to poor welfare with an increase in abnormal behavior including bar-biting. This study was conducted to evaluate the availability of the sling belt as nesting materials in the crating system. We housed 29 sows (19L, 10Y) in the farrowing crate (0.8 × 2.0 m) one week before parturition, and allocated to three groups, 1) C (n = 9): no nesting materials were provided, 2) S (n = 11): a sling belt was horizontally tied in front of the feeding trough, 3) ST (n = 10): a sling belt and towel horizontally tied in front of the feeding trough. Nest-building and bar-biting behavior for 24 h before parturition were determined by video observation with three trained researchers. The sows in ST showed a longer duration of nest-building than the sows in S or C (p < 0.0001). Moreover, nest-building frequency of the ST sows tended to be higher than the other groups (p = 0.05). On the other hand, sows in C showed higher frequency of bar-biting than S and ST (p < 0.0001). In conclusion, our results may suggest that the provision of the sling belt can improve welfare of the crated sows and thus may have a potential to improve their farrowing and lactating performance.

P-45

The provision of the sling belt reduces salivary cortisol levels and aggressive behavior of the growing pigs immediately after transportation and regrouping

Kim JS[1], LEE JH[1], Kang KW[2], JO HW[2], Yun J[1]

[1]Department of Animal Science, Chonnam National University, Gwangju, Korea
[2]Swine Research Center, Sunjin R&D Institute, Sunjin Co., Ltd., Korea

ABSTRACT

The study evaluated whether the provision of polyester sling belts as an enrichment material for growing pigs immediately after transportation and grouping affects body weight, salivary cortisol, and behavior. In total, 319 growing pigs (initial BW: 29.5±1.9 kg) were assigned to one of three treatments with increasing the number of the sling belt: 0(S0), 3(S3), and 6(S6). After two hours of transportation, the pigs were housed on a totally concrete slatted floor and newly mixed with 50-55 pigs per pen. On days 0 and 6, body weight was measured. On days 1 and 2, saliva samples from three pigs per pen were collected for cortisol analysis. The pens were observed using video recordings for 24h after mixing. At day 6, body weight did not differ between treatments (S0: 34.1±1.8, S3: 33.1±2.7, S6: 34.0±2.6, kg, respectively). The salivary cortisol levels of the pigs with S6 tended to be lowest at day 1 ($p = 0.06$) or were lowest at day 2 ($p < 0.05$) among the treatments. Negative social behavior (i.e., aggression, including biting and disturbing other mates) was more observed in pen with S0. In contrast, exploration behavior (i.e., investigating all features except the sling belt in pen) was also more observed in pen with S0 than in S3 and S6. Results indicate that providing the sling belt reduces the social stress and aggressive behavior of newly mixed growing pigs. These data thus suggest that the provision of the sling belt could benefit potential pig welfare after mixing.

P-46

RNAi-based Functional Analysis of Molting Fluid Chitinases from the Japanese Pine Sawyer Beetle

Youngseo Lee[1], Seulgi Mun[2], Yasuyuki Arakane[2] and Mi Young Noh[1]

[1]Department of Forest Resources, Chonnam National University, Gwangju 61186; [2]Department of Applied Biology, Chonnam National University, Gwangju 61186

ABSTRACT

Insect cuticle is an extracellular matrix formed primarily from two different biopolymers, chitin and protein. During each molt cycle, a new cuticle is deposited simultaneously with degradation of the old one by molting fluid cuticle degrading-enzymes, including epidermal group I and II chitinases (CHTs). Insect chitinases belong to family 18 glycosylhydrolase (GH-18) and have been classified into at least eleven groups based on phylogenetic analysis. In this study, we report physiological functions of the molting fluid chitinases, MaCHT5 (group I) and MaCHT10 (group II), including two alternatively spliced isoforms of the later, MaCHT10a and MaCHT10b, from the Japanese pine sawyer beetle, *Monochamus alternatus*. RNA interference (RNAi) studies reveal that MaCHT5 is required for both larval-pupal and pupal-adult molts, while depletion of MaCHT10a has little or no effect on those molts. RNAi for both *MaCHT10a* and *MaCHT10b*, however, causes failure of pupation and adult eclosion. All of these results suggest functional specialization of insect molting fluid chitinase genes.

P-47

Function of *yellow-y* in adult cuticle melanization of *Monochamus alternatus*

Jihwan Han[1], Jiyun Wi, Mi Young Noh[1]
Department of Forest Resources, Chonnam National University

ABSTRACT

Cuticle tanning (pigmentation and sclerotization) is an important physiological event in insect development. In this vital metabolism initiated with tyrosine, dopachrome conversion enzymes (DCEs) encoded by the *yellow* genes accelerate significantly melanization reaction. Insect *yellow* is a rapidly evolving gene family generating functionally diverse paralogs. In this study we identified, cloned cDNA and investigated the function of *yellow-y* (*MaY-y*) in adult cuticle melanin-type pigmentation of the Japanese pine sawyer beetle, *Monochamus alternatus*, which is a major vector of the pinewood nematode, *Bursaphelnchus xylophilus* that causes Pine wilt disease. Real-time qPCR revelated that *MaY-y* was sharply induced in day 9 pupae and declined thereafter during late developmental stages. Loss of function of *MaY-y* caused by RNAi had no effect on larval and pupal development. However, the resulting adults exhibited a reddish-brown body wall and elytra as well as bristles instead of a black coloration in the control animals. These results indicate that MaY-y has a critical role in normal black pigmentation of *M. alternatus* adult.

P-48

Evaluation of quality characteristics of reduced-salt, low-fat pork sausages with faba bean protein isolate and microbial transglutaminase

Geon Ho Kim[1], Koo Bok Chin[1]

[1]Department of Animal Science, National University, Gwangju, 61186, Republic of Korea

ABSTRACT

The objective of this study was to evaluate the effect of faba bean protein isolate (FBPI) and microbial transglutaminase (MTG) on physicochemical and textural properties of reduced-salt, low-fat pork sausages (LFPSs). Pork sausages (PSs) were prepared four treatments: REF, LFPS with 1.5% salt; CTL, LFPS with 1.0% salt; TRT1, LFPS with 1.0% salt and 1.5% FPBI; TRT2, LFPS with 1.0% salt, 1.5% FBPI and 1.0% MTG. Back extrusion (gf) values of TRT2 were higher than those of other treatments, and REF and TRT1 were not different in the back extrusion. Cooking loss (CL, %) and expressible moisture (EM, %) of TRT1 and TRT2 were higher than those of CTL. REF and TRT1 had higher hardness (gf) values than CTL, and those of TRT2 were the highest among all treatments. Springiness (mm), gumminess, and chewiness values of TRT1 and TRT2 were similar to those of REF, however all textural properties of CTL were lower than those of REF. Hydrophobicity (μm) values of REF and TRT1 were not different, but those of TRT2 were lower than TRT1. Sulfhydryl groups of TRT2 were the lowest among all treatments, whereas TRT1 had similar values to REF. No differences in moisture content (%) were observed among all treatments. Fat contents (%) of TRT1 and TRT2 were lower than those of REF and CTL, but TRT1 and TRT2 had higher protein contents than other treatments. Therefore, the combination of FBPI and MTG might be useful in the development of reduced-salt PSs with improved water-holding capacity and texture properties.

P-49

AA15 lytic polysaccharide monooxygenase is required for chitinous cuticle turnover during insect molting

Myeongjin Kim[1], Seulgi Mun[1], Mi Young Noh[2], Karl J. Kramer[3], Subbaratnam Muthukrishnan[3] and Yasuyuki Arakane[1]

[1]Department of Applied Biology, Chonnam National University

[2]Department of Forest Resources, Chonnam National University

[3]Department of Biochemistry and Molecular Biophysics, Kansas State University

ABSTRACT

Lytic polysaccharide monooxygenases (LPMOs) catalyze the oxidative cleavage of glycosidic bonds in crystalline polysaccharides including chitin and cellulose. The recent discovery of a large assortment of LPMO-like proteins widely distributed in insect genomes suggests that they could be involved in chitin degradation in the cuticle, tracheae and peritrophic matrix during development. However, the physiological functions of insect LPMO15s are still undetermined. A phylogenetic analysis indicates that insect LPMO15s could be divided into at least four subgroups. In this study, we investigate the function of subgroup I LPMO15 (TcLPMO15-1) in the red flour beetle, Tribolium castaneum. RNAi studies show that TcLPMO15-1 is required for molting at all developmental stages. TEM analyses reveal failure of turnover of chitinous cuticle. These results indicate that TcLPMO15-1 plays an important role in cuticular chitin degradation, which is critical for completion of insect molting.

P-50

Application of machine learning technique for runoff prediction in watershed with limited data

Minhyuk Jeung, Jina Beom, Minkyeong Park, Jiyeon Jeong, Kwangsik Yoon
전남대학교 농업생명과학대학 지역바이오시스템공학과

ABSTRACT

기후변화로 인한 자연재해는 해마다 크게 증가하고있으며, 홍수 및 가뭄의 강도와 빈도 증가, 지구온난화로 인한 하천 건천화 등 많은 문제들이 대두되고 있다. 특히, 물 순환 과정의 핵심요소로 설명되는 유출량의 변동은 용수 공급과 홍수 대응 및 관리, 하천생태계 유지를 위한 환경에 영향을 미치고 있다. 따라서, 갈수량, 풍수량 등을 산정하여 하천별 유황특성을 결정하는 방법을 사용하고 있으나, 이와같은 지표는 계측자료가 과소한 경우 하천의 유황특성을 세부적으로 이해하고 정량적으로 제시하는데에 한계가있다. 따라서, 미계측 유역에서 Soil and Water Assessment Tool (SWAT)과 같은 수리해석모델이 광범위하게 이용되고있으며, SWAT 모델은 유역의 수치표고모형, 토양 특성, 토지이용 현황, 기상 현황, 유역의 매개변수 등을 반영하여 모델이 구동되고 있다.

하지만, 광범위하게 이용되고 적용성이 입증된 모델임에도 불구하고 입력자료의 불확실성 및 조사되지 않은 영농활동 등으로 인해 결과에 불확실성이 내포되어있으며, 불확실성을 줄이기 위해 실측된 하천의 유량 자료를 이용하여 검정 및 보정작업을 거치고 있다.

모델의 보정 방법으로는 SWAT-CUP과 같은 프로그램 이용되고 있지만, 모델에서 이용되는 매개변수로는 보정할수 있는 범위가 한정적이기 때문에 모델의 정확성을 높이는데에 한계가 있다.

따라서, 본 연구에서는 선암천 유역을 대상으로 모델의 매개변수를 보정하지 않고도 머신러닝 기법을 이용하여 모델의 결과를 향상시켰다. 보정 결과, 유량의 경우 R^2가 0.42에서 0.91으로 향상되었으며, 특히 고유량 구간에서의 정확성이 매우 향상되었다.

본 연구에서 평가된 SWAT+머신러닝 결합 모형은 향후 모델 구동에 필요한 입력자료가 부족한 경우와 빠른 검정 및 보정 작업이 필요할 경우 활용될수 있을것으로 판단된다.

핵심용어 : SWAT, 랜덤 포레스트, 유량 해석, 모델 검보정

감사의 글

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P-51

수침고목재의 화학적 특성 및 미생물 군집 분석

임주원, 김종식
전남대학교 농업생명과학대학 임산공학과

ABSTRACT

수침고목재(waterlogged archeological wood)는 호수, 저습지, 토탄층, 해양 등에서 출토되는 고목재로, 매장과정에서 다양한 미생물에 의해 분해된다. 일반적으로 수침고목재의 미생물 분해에는 호기성(aerobic)인 갈색부후균(brown rot fungi)이나 백색부후균(white rot fungi)과 같은 담자균(Basidiomycota)은 관여하지 않으며, 주로 혐기성(anaerobic) 조건에서도 생장이 가능한 세균(bacteria)에 의해 발생한다. 경우에 따라서는 불완전균(Fungi imperfecti)나 자낭균(Ascomycota)에 속한 연부후균(soft rot fungi)에 의해 수침고목재가 분해된다. 본 연구에서는 광주광역시 동림동 저습지에서 발굴된 3점의 활엽수재(hardwood) 수침고목재(동림 20~23)를 대상으로 미생물 분해에 따른 최대함수율(maximum moisture content)과 화학적 조성분의 변화를 분석하고, 차세대염기서열 분석(next generation sequencing, NGS)을 통해 관련 미생물 군집(microbial community)을 조사하였다. 수침고목재의 최대함수율은 631~1,006%로 매우 높은 열화(deterioration) 수준을 나타내었다. 미생물 피해를 받지 않은 정상재와 비교하여 모든 수침고목재에서 홀로셀룰로오스 함량(25~36%)은 크게 감소하고, 리그닌 함량(65~71%)은 크게 증가하였다. 이는 다당류를 주로 분해하는 미생물에 의해 동림동 수침고목재가 열화된 것을 의미한다. 2점(동림 21, 22)의 수침고목재에 대한 미생물 군집 분석 결과, 문(phylum _ 수준에서 진균(fungi) 군집에서는 자낭균문(99%), 세균 군집에서는 Proteobacteria문(33.6~55.2%)이 가장 큰 비율을 차지하였다. 다음으로 동림21에서는 Acidobacteria문 (27.9%), Actinobacteria문 (22.8%), 동림22에서는 Chloroflexi문 (8.6%), Bacteroidetes문 (8.4%) 순으로 높은 비율을 차지하는 등 동일 지역에서 발굴된 두 수침고목재라 할지라고 미생물 군집에 뚜렷한 차이를 나타내었다.

P-52

The impact of the microalgea *Chlorella Vulgaris* suplementaion on in vitro rumen fermentation and methane production.

Seon HS[1], Sim SH[2], Lee HS[1], Park CJ[1], Kim ZH[2], Lee CS[2], Kim M[1]

[1]Division of Animal Science, College of Agriculture and Life Sciences, Chonnam National University, Gwangju 61186, Korea

[2]Microbial Research Department, Nakdongang National Institute of Biological Resources, Sangju 37242, Korea.

ABSTRACT

The objective of this study is to evaluate the impact of microalge *Chlorella Vulgaris* as an additive on in vitro rumen fermentation and methane production. *Chlorella Vulgaris* was provided by Nakdonggang National Institute of Biological Resources(Sangju, Gyeongsangbuk-do, South Korea). Ruminal fluid obtained from three Hanwoo cattle was used for the *in vitro* incubation. The TMR (containing 11.5% CP, 5.1% EE, 52.2% NDF and 27.0% ADF) was used as the basic substrate. Three levels of *C. vulgaris* were supplemented to the basic substrate: 0.1%, 0.5% and 1.0% of the substrate. A control group contained the basic substrate without *C. vulgaris* supplementation. After 6h, 12h and 24h incubation, pH, *in vitro* dry matter digestibility (IVDMD), methane production, total gas production and VFA were determined. All three levels of *C. vulgaris* supplementations had no effect on pH and total gas production. At 24h incubation, IVDMD was greater ($p < 0.05$) in the 1.0% supplementation group than in the control group whereas methane production was lower ($p < 0.05$) in the 1.0% supplementation group than in the control group. Propionate and Butyrate were lower ($p < 0.05$) in the 1.0% supplementation group than in the control group at 6h incubation. However, All three levels of *C. vulgaris* supplementations had no effect on VFA, and acetate and propionate ratio at 12h and 24h incubations. This study indicate that the microalgae *Chlorella Vulgaris* may be used as a potential additive reduce methane emissions from ruminants without affecting rumen fermentation.

P-53

Effect of the microalgae *Parachlorella sp.* supplementation on *in vitro* rumen fermentation and methane production

Sim SH[1], Lee HS[1], Seon HS[1], Park CJ[1], Kim ZH[2], Lee CS[2], Kim M[1]

[1]Division of Animal Science, College of Agriculture and Life Sciences, Chonnam National University, Gwangju 61186, Korea,
[2]Microbial Research Department, Nakdongang National Institute of Biological Resources, Sangju 37242, Korea

ABSTRACT

The objective of this study was to evaluate the effect of the microalgae *Parachlorella sp.* on *in vitro* rumen fermentation and methane production. *Parachlorella sp.* was provided by the Nakdonggang National Institute of Biological Resources, Korea. Rumen fluid was collected from three Hanwoo cattle and was used for the *in vitro* incubation. The TMR (containing 11.5% CP, 5.1% EE, 52.2% NDF and 27.0% ADF) was used as the basic substrate. The following levels of *Parachlorella sp.* were supplemented to the basic substrate: 0%(control), 0.1%, 0.5% and 1% of the substrate. After 6h, 12h and 24h incubation, pH, *in vitro* dry matter digestibility (IVDMD), ammonia nitrogen (NH_3-N), methane production, total gas production and VFA were determined. The pH was greater (p < 0.01) in all supplementation groups than in the control group at 12h incubation while IVDMD was greater (p < 0.01) in all supplementation groups than in the control group at 24h incubation. The NH_3-N was lower (p < 0.01) in all supplementation groups than in the control group at 12h incubation. The methane production was lower (p < 0.01) in all supplementation groups than in the control group at 24h incubation. All three levels of *Parachlorella sp.* supplementations had no effect on total gas production, acetate, propionate, and acetate to propionate ratio. This study indicates that the supplementation of the microalgae *parachlorella sp.* can reduce methane production without affecting rumen fermentation and may provide new opportunities for strategies to reduce greenhouse gas emissions.

P-54

Osteoclast differentiation inhibitory activity of octadecadienediynoic acids isolated from the leaves of Dendropanax morbiferus

Jin-Hyeok Choi[1], Young-Shin Park[1], Jae-Hak Moon[1], Kye-Han Lee[2], Byung-Doo Lee[3], A-Ra Jang[4], Jong-Hwan Park[4], and Jeong-Yong Cho[1]

[1]Department of Food Science & Technology, Chonnam National University, Gwangju 61186, Korea
[2]Department of Forest Resources, Chonnam National University, Gwangju 61186, Korea
[3]Gangsan Farm, Jeonnam 59450, Korea
[4]Laboratory of Animal Medicine, College of Veterinary Medicine and BK21 Plus Project team, Chonnam National University, Gwangju 61186, Korea

ABSTRACT

Dendropanax morbiferus belongs to the Araliaceae family and is widely distributed in the southern area of Korea. Various chemical constituents, including alkaloids, polyacetylenes, phenylpropanoids, flavonoids and terpenoids are contained in D. morbiferus. Prior studies on various biological activities of D.morbiferus such as antioxidant, anti-diabetic, anti-cancer, and osteoclast differentiation inhibitory have been conducted. However, studies on the osteoclast differentiation inhibitory activity of octadecadienediynoic acids from the leaves of D. morbiferus are inadequate. In this study, we additionally isolated and purified two compounds and elucidated as octadecadienediynoic acids based on HR-ESI-MS and 1D- and 2D-NMR analyses. The octadecadienediynoic acids inhibited the receptor activator of nuclear factor-κB (RANKL)-induced osteoclast differentiation of bone marrow derived macrophage. These compounds effectively suppressed the expression of osteoclast-related genes, such as TRAP, cathepsin K, NFATc 1, and DC-STAMP. These results indicate that octadecadienediynoic acids may be contributed to the osteoclast differentiation inhibitory effect of D. morbiferus.

P-55

Chemical Conversion of *Epicatechin 3-O-gallate* by Boiling in Water Solution

Dong-Gwan Kim[1], Jeong-Yong Cho[1], Jae-Hak Moon[1]

[1]Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Korea

ABSTRACT

Foods are usually consumed through boiling during cooking process. However, the research of the chemical conversion by boiling in water solution is not still extensively studied. Therefore, *epicatechin 3-O-gallate* (ECG)was used in the study on chemical conversion by boiling in water solution. ECG in water was heated at 100℃ for 10 hr, and the solution was analyzed using HPLC-PDA. Five or more newly produced compounds (NPCs) were observed. In addition, the reacted solution was subjected to LC-MS/MS analysis for identification of the compounds. The structure of several compounds of the NPCs could be predicted. However, for the more accurate identification, purification and isolation of NPCs, and the structural determination by MS and NMR analyses of the NPCs is in progress. It is suggested that the NPC may be produced by oxidation, hydration, and radical reaction during the boiling of ECG in water solution. This study is expected to be used as important basic data in studies related to cooking, processing, function of foods and oriental medicines.

P-56

Whole cell-based biosensor to detect heavy metals in foods

Taeok Kim
Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University

ABSTRACT

The heavy-metal pollution in foods is one of the important issues with respect to food safety because it causes many pathologies from neurodegenerative diseases, cancers, and metabolic disorders.

The expensive equipments and experts are required to detect heavy metals in the foods

To solve this problem, we constructed whole cell-based biosensors for detection of heavy metals, especially the determination of arsenic and mercury in seaweed.

Two different whole cell biosensors consist of three parts: reporter genes (*gfp*), heavy metal inducible promoter (P_{arsR}, P_{merT}), and its regulatory protein gene (*arsR*, *merR*).

The sensing mechanism relies on the selective recognition from the bacterium of given metals and producing the green fluorescent protein (gfp).

The constructed biosensors were able to rapid and high-sensitively detect arsenic and mercury with a LOD of 1.5 ppb and 0.5 ppb, respectively.

These biosensors were applied to detect arsenic and mercury in seaweed.

These results pave the way for advanced sensing strategies suitable for the food safety monitoring.

P-57

Allergy-Inducing Characteristics of Newly Synthesized Urushiol Derivatives, Different Side Chain Hydrocarbon Length

Hye-Ra Choi[1], Gwang-Woo Lee[1], Hyoung Jae Lee[1], Jeong-Yong Cho[1], Jae-Hak Moon[1]

[1]Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Korea

ABSTRACT

Urushiol, a major component of lacquer tree (*Rhus veniciflua*) sap, has been reported to exert anticancer, antioxidative, and antibacterial activities. However, its utilization is difficult due to allergy-inducing property. Our previous studies revealed that the hydroxyl group of catechol and the length of side-chain hydrocarbons bounding to C-3 position of catechol are factors involved in allergy induction and physiological activity. Therefore, in this study, we evaluated the allergy-inducing characteristics according to the length of side-chain hydrocarbons [$-C_3H_7$, $-C_6H_{13}$, $-C_7H_{15}$, $-C_8H_{17}$, $-C_9H_{19}$] through animal experiments using five newly synthesized UDs. That is, five synthetic UDs were applied on the rear of left ear of rats (Sprague-Dawley, ♂, six weeks old, 40 mg/kg body wt.) once daily for 10 days by 3 μmol, and morphological and serological analyses (hypersensitivity-related biomarkers: neutrophils, eosinophils, serum IgE and histamine) were performed. Consequently, it was clarified that the degree of erythema and swelling as well as the hypersensitivity-related biomarker levels were proportional to the length of the side-chain hydrocarbon in UDs.

P-58

Optimization of combined cell-free transcription–translation system in *Saccharomyces cerevisiae*

Chae-Rim Jeong and Soo-Jung Kim

Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju 61186, Republic of Korea

ABSTRACT

Cell-free gene expression system is a convenient platform that has been emerging in protein engineering and synthetic biology. Since *Saccharomyces cerevisiae* is a model microorganism for the combined cell-free transcription–translation (Tx–Tl) system, we optimized a cell-free Tx–Tl system to express target proteins. To determine the effect of introducing helper sequences to target DNA on facilitation of Tx and Tl, tobacco mosaic virus-derived Ω sequences and poly(A) tail were introduced to 5′-UTR and tail, respectively. Next, the fragments and plasmids were tested. Consequently, the fragments showed the highest expression, exhibiting saturated fluorescence in 6 hours, which was more than twice as high as in the case of the plasmids. In addition, expression was compared by varying the cofactors. Finally, system was found to produce GFP in 1.5 hours without capping, thus making it a time- and cost-effective approach. Furthermore, we also confirmed that the cell-free system could be used for high-throughput screening using signal proteins, such as GFP. These results suggest that a platform of cost-effective and time-efficient yeast cell-free system can be apply to *in vitro* study.

P-59

Production of shinorine from lignocellulosic biomass by metabolically engineered *Saccharomyces cerevisiae*

So-Rim, Kim[1], So-LEE, Kang[1], Soo-Jung, Kim[1*]

Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju, Korea

ABSTRACT

Mycosporine-like amino acids (MAAs) have been used in cosmetics and pharmaceuticals. The purpose of this work was to develop yeast strains for sustainable and economical production of MAAs, especially shinorine. Firstly, genes involved in MAA biosynthetic pathway from *Actinosynnema mirum* were introduced into *Saccharomyces cerevisiae* for heterologous shinorine production. Secondly, combinatorial expression of wild and mutant xylose reductase was adopted in the engineered *S. cerevisiae* to facilitate xylose utilization in the pentose phosphate pathway. Finally, the accumulation of sedoheptulose 7-phosphate (S7P) was attempted by deleting transaldolase-encoding *TAL1* in the pentose phosphate pathway to increase carbon flux toward shinorine production. In fed-batch fermentation, the engineered strain (DXdT-M) produced 751 mg/L of shinorine in 71 h. Ultimately, 54 mg/L of MAAs was produced by DXdT-M from rice straw hydrolysate. The results suggest that shinorine production by *S. cerevisiae* might be a promising process for sustainable production and industrial applications.

P-60

Biohydrogen production from Brewers' spent grain by hyper-thermophilic *Caldicellulsiruptor bescii*

Hyo-Jin Choi[1], Jun-Ha Kim[1], Sun-Ki Kim[2], Won-Heong Lee[1*], and Soo-Jung Kim[1*]

[1]Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju, Korea

[2]Department of Food Science and Technology, Chung-Ang University, Anseong, Gyeonggi 17546, Republic of Korea

ABSTRACT

Biohydrogen is a promising alternative to fossil fuels and expected to serve as the future energy carrier due to carbon-free property and higher energy content relative to hydrocarbon fuels. Hyperthermophile, *Caldicellulosiruptor bescii* is recognized as an emerging hydrogen producer because it has ability to deconstruct non-pretreated plant biomass and metabolize multiple sugars simultaneously. In this study, we utilized Brewers' spent grain (BSG), an unavoidable waste material produced during beer brewing, as a sole carbon source for fermentation of *C. bescii*. The application will help facilitate the eco-friendly and sustainable production of biohydrogen using *C. bescii*.

This results was supported by "Regional Innovation Strategy (RIS)" through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (MOE)(2021RIS-002).

Keywords: biohydrogen; *Caldicellulosiruptor bescii*; Brewers' spent grain (BSG)

P-61

Optimization of hydrolysis parameters for extraction of monomeric sugars from Burdock (*Arctium lappa* L.) root wastes

Shakti Chandra Mondal[1] and Jong-Bang Eun[1]*

[1]Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju, South Korea

ABSTRACT

Burdock (*Arctium lappa* L.) is a medicinal food plant planting in various countries and using as an herbal and tea. However, after extracting the juice, the remaining waste materials are discarding without proper use. Hence, valorization of those wastes would be a promising way to minimize the environmental pollution and could be used as a raw food materials for the growth of organisms or future use. In this study, hydrolysis process was optimized to extract the monomeric sugars from the burdock roots. Three parameters such as extraction time (20, 40, and 60 min), extraction temperature (40, 65, and 90°C) and solid to liquid ratio (1:20, 1:25 and 1:30) were optimized with Response Surface Methodology (RSM) with face centered central composite design. Result revealed that solid to liquid ratio was the most important parameter that significantly influences on the hydrolysis process (p<0.05). However, time and temperature showed non-significant influence on extraction. Optimized time, solid to water ratio and temperature were found to be 33.39 min, 1:20.01 and 65.28°C respectively with the expectation of 2.59 g/kg of reducing sugar.

P-62

Combined effect of sulfuric acid and ethanol to retain polysaccharide from Burdock (*Arctium lappa* L.) root

Shakti Chandra Mondal[1] and Jong-Bang Eun[1]*

[1]Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju, South Korea

ABSTRACT

Burdock (*Arctium lappa* L.) roots are valuable sources for fructan type fructooligosaccharide/polysaccharide which exerts various bioactivity. In this study, sulfuric acid was used in combination with ethanol hence, ultrasonic extraction parameters such as 70% ethanol content (20-40 g/ml), sulfuric acid (1-5 ml), sonication time (30-90 min), and sonication temperature (35-75 ^{o}C) were optimized using response surface methodology (RSM). After multiple linear regression analysis, a second-order polynomial model was developed for response (yield of total polysaccharide). Results revealed that the ethanol content and sonication temperature and time have the significant effect (p< 0.05) on the extraction of polysaccharide from the burdock roots with the R^2 value of 0.89. With the numerical optimization the polysaccharide yield was expected to 43.52% with 25.48 ml/g of ethanol, 4.0 ml H_2SO_4, 65°C temperature and time of 75 min. From this experiment, we observed that sulfuric acid can break down the lignin and other complex carbohydrate which may be extracted by effective solvents.

P-63

Effect of UV Irradiation on Physicochemical Characteristics and Antioxidant Activities of cold brewed coffee

A-Hyeon Kim[1], Jin-Young Moon[1], Suk-Min Yun[1], Jong-Bang Eun[1*]

[1]Department of Integrative Food, Bioscience and Biotechnology, Graduate School of Chonnam National University, S. Korea

ABSTRACT

Cold brewed coffee (CBC) was irradiated with UV at flow rates of 50, 75, and 100% (2 L/min) for 1 to 3 minutes for sterilization. Since microorganisms were not detected the CBC before sterilization, the physicochemical characteristics and antioxidant activities were investigated to see the influences by UV irradiation in the CBC. Soluble solid contents, L^* and a^* values were all higher than those of the control, except for treated with flow rate 50% (2 L/min) for 3 minutes. The b^* and pH values increased as the flow rate became slower and time increased. Total phenolic and total flavonoid contents, and 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferric reducing antioxidant power (FRAP), 3-ethyl-benzothiazoline-6-sulfonic acid (ABTS) for antioxidant activities increased as the flow rates decreased; however, as the irradiation time increased, those values decreased. In conclusion, there was a change in the value of physicochemical properties, but there was no significant effect, and it had a significant effect on the value of antioxidant activity. It is necessary to study sterilization effect of UV irradiation in CBC after inoculation of microorganisms on it in the future.

P-64

Thermo-oxidative stability of different multi-element oleogels of carnauba wax, β-sitosterol / lecithin and ethyl cellulose

Qiu Hongtu, Jong-Bang Eun

Department of Integrative Food, Bioscience and Biotechnology, Graduate School of Chonnam National University, S. Korea

ABSTRACT

The oxidation of oleogel was interpreted by measuring the peroxide value (POV), anisidine value (P-AV), total antioxidant value (TOTOX), 2-thiobarbituric acid value (TBA) of different multi-element oleogels (DMEO). Combining cluster analysis (CA), principal component analysis (PCA) and linear discriminant analysis (LDA) of the electronic nose were used. Results showed that the gelation temperature of the oleogels determines its oxidation degree. The oleogel prepared using ethyl cellulose (ECO) showed the highest oxidation value compared to the oleogel prepared using β-sitosterol and lecithin (S/LO) and the oleogel prepared using carnauba wax (CWO). Loading resveratrol (RE) and added surfactants can effectively reduce the oxidation of oleogels. Oleogels were more sensitive to nitrogen oxides and methane substances in the thermal oxidation process than other compounds, such as aromatic components, aldehydes and ketones. Therefore, TBA is not suitable for evaluating oxidation degree of oleogels, while POV and P-AV would be used to measure the degree of oxidation of oleogel. CA, PCA, LDA qualitative discrimination of DMEO oxidation classification accuracy rate was as high as more than 90%. Therefore, electronic nose technology might be an innovative tool for rapid detection of oleogels oxidation.

P-65

Changes in physicochemical characteristics of two types of ramen sauces during storage at different temperatures

A-Ra Shin[1], Se-Jin Park[2], Soo-Jung Kim[1,2], Jong-Bang Eun[1,2*]

[1]Department of Food Science and Technology, Chonnam National University, S. Korea, [2]Department of Integrative Food, Bioscience and Biotechnology, Graduate School of Chonnam National University, S. Korea

ABSTRACT

The physicochemical characteristics of the two types of sauces, spicy ramen sauce (SRS), and plain ramen sauce (PRS) were investigated during storage at 25°C, 35°C, and 45°C. While the pH and moisture contents of SRS and PRS decreased during storage, the total acidity of both products increased at all temperatures. Both SRS and PRS experienced an increase in viscosity until 40 days of storage at all temperatures, but they decreased after that time. In color, a* value of PRS increased and its L* and b* values decreased. In both sauces, maltose and glucose contents decreased as the storage period and temperature increased. The lactic acid and acetic acid contents, however, were not significantly changed at the beginning, but increased towards the end. TBARS increased in the both sauces with increasing in storage temperature and time. In conclusion, increase of rancidity, reduction of moisture and decrease of pH were shown during storage; therefore, packaging method for their storage should be investigated to prevent them in the future.

P-66

Loading mechanism of resveratrol in different multi-element oleogels systems and simulated digestion *in vitro*

Qiu HongTu, Jong-Bang Eun.

Department of Integrative Food, Bioscience and Biotechnology, Graduate School of Chonnam National University, Gwangju, S. Korea

ABSTRACT

This work focused on inferring the loading mechanism of resveratrol (lipophilic bioactive substance) in different oleogel systems using peanut oil (P) and soybean oil (S) multi-element (binary, ternary, quaternary) with sitosterol/lecithin (L/S), carnauba wax (CW), and ethyl cellulose (EC) and simulated *in vitro* digestion experiment. The results of micro and macro (resveratrol loading, texture properties, microstructure, crystal structure, thermal stability, rheological behavior) experiments were measured. With the increase of element units, the three oleogels series all improved the embedding rate of resveratrol (% quaternary EC-S, EC-P: 97.39, 99.51; CW-S, CW-P: 95.98, 98.80; L/S-S, L/S-P: 59.28, 72.69), oleogels hardness, strength, solid fat content, oil binding force and bioavailability (% quaternary EC-S, EC-P:72.97, 74.66; CW-S, CW-P : 67.33, 71.28; L/S-S, L/S-P: 57.73, 62.79). Loading resveratrol and adding surfactants improved the stability of the network structure of the oleogels. The oil containing more polyunsaturated fatty acids with a single supramolecular oleogelator to prepare oleogels are more suitable as a carrier for lipophilic biologically active substances.

P-67

Physicochemical Characteristics of Gluten-Free Vegan Scones made of different rice flours

Seong-Hyun Choi[1]*, Su-Hui Bang[1], Yeong-Ji Yun[1], Tae-Yeon Kim[1], Hye-Jin Park[1], A-hyeon Kim[2], Jong-Bang Eun[1,2]

[1]Department of Food Science and Technology, Chonnam National University, S. Korea
[2]Department of Integrative Food, Bioscience and Biotechnology, Graduate School of Chonnam National University, S. Korea

ABSTRACT

Glutinous rice flour and non-glutinous rice flour were compared to make scone for vegans and a gluten-free product and some substitutes for ingredients of scone were also investigated for the gluten-free scone for vegans (GFVS). Milk and butter were substituted for soy milk and margarine. Xanthan gum and guar gum were added to give better structural stability and vanilla oil was also used for better flavor. The moisture contents of scone with glutinous rice (GRS) and scone with non-glutinous rice (NGRS) were higher than the control. The GRS had the highest pH value, but there were no significant differences between the control and NGRS. The dough with GRS had the highest density, but the control and NRS were not significantly different. The baking loss was the highest in the control and the lowest in NGRS. the value of L* and b* was high in control while NGRS had the least value of L* and b*. The value of a* was high in NGRS while the control had the lowest value of a*. In texture properties of the scones, the cohesiveness was the highest in the control and the lowest in NRS. In hardness, GRS did not show significant difference, compare to the control and NGRS and NGRS was higher than the control. In sensory evaluation, Puffiness is not significantly different among the samples. In flavor, the control did not show significant difference with GRS, and was higher than NGRS. The control and GRS showed higher score than NGRS in the overall acceptability. In conclusion, glutinous rice flour showed better quality than non-glutinous rice flour to make GFVS and the glutinous rice flour used in this study could be good to make GFVS.

P-68

The change of color and pH value of skate muscle during fermentation at different fermentation conditions

A-hyeon Kim[1]*, A-Ra Shin[2], Jong-Bang Eun[1,2]

[1]Department of Integrative Food, Bioscience and Biotechnology, Graduate School of Chonnam National University, S. Korea

[2]Department of Food Science and Technology, Chonnam National University, S. Korea

ABSTRACT

This study investigated the effects of fermentation conditions on the color and pH values of the fermented skate muscle up to 15 days at 10°C during fermentation. Three fermentation conditions, at air, vacuum and different gas composition (oxygen:nitrogen =100:0, 70:30, 50:50, 30:70 and 0:100) were used. The a* value of sample fermented at air decreased with increasing fermentation time. On the other hand, it decreased up to 10 days of fermentation and then started to decrease. The yellowness (b*) was decreased in the sample fermented at air and the sample fermented at 100% nitrogen. However, the pH values of the skate muscle increased significantly in all the fermentation conditions. In particular, pH of the skate muscle fermented at 100% nitrogen showed the least increment from 7.47 to 8.51 compared to the others, to more than 9.0. Therefore, to finalize the optimization of the fermentation condition for the fermented skate muscle, the chemical parameters of the skate muscle color, such as myoglobin, should be studied further in the future.

P-69

Inhibition of browning by microwave blanching for manufacturing onion powder

A-Hyeon Kim[1*], A-Ra Shin[2], Ji-Won Kim[2], Si-Hyun Lee[2], Seo-Yeon Lee[2], Jong-Bang Eun[1,2]

[1]Department of Integrative Food, Bioscience and Biotechnology, Graduate school of Chonnam National University, Gwangju, 61186, Republic of Korea

[2]Department of Food Science and Technology, Chonnam National University, Gwangju, 61186, Republic of Korea

ABSTRACT

In this study, microwave blanching was used to inhibit browning for manufacturing onion powder before hot air drying. After 50s of microwave blanching, the onion sample was scorched. Therefore, sliced onions were blanched with using pulsed microwave of 700W, 2450 MHz for 25, 35 and 45 seconds and then dried at 55℃ for 97 hours. The peroxidase activity of onions blanched with microwave was measured. The moisture content and color value of the onion powder were determined. The moisture contents of the onion powder were shown from 9.26% to 11.75%. The peroxidase activity of onions decreased with increasing microwave blanching time before drying. However, in color value, the L* value decreased as the microwave blanching time increased. This result suggested that microwave blanching could inhibit the enzymatic browning of onion, but non-enzymatic browning might be happened more by heating for drying. In conclusion, microwave blanching worked for inhibition of enzymatic browning; however, the inhibition of non-enzymatic browning should be studied for the manufacturing of onion powder in the future.

P-70

Rice peroxygenase catalyzes lipoxygenase-dependent regiospecific epoxidation of lipid peroxides in the response to abiotic stressors

Anh Duc Tran[1], Kyoungwon Cho[1], Oksoo Han[1,*]

[1]Department of Molecular Biotechnology and Kumho Life Science Laboratory, College of Agriculture and Life Sciences, Chonnam National University, Gwangju 61186, Republic of Korea.

ABSTRACT

The peroxygenase pathway plays pivotal roles in plant responses to oxidative stress and other environmental stressors. Analysis of a network of co-expressed stress-regulated rice genes demonstrated that expression of OsPXG9 is negatively correlated with expression of genes involved in jasmonic acid biosynthesis. DNA sequence analysis and structure/function studies reveal that OsPXG9 is a caleosin-like peroxygenase with amphipathic α-helices that localizes to lipid droplets in rice cells. Enzymatic studies demonstrate that 12-epoxidation is slightly more favorable with 9(*S*)-hydroperoxyoctadecatrienoic acid than with 9(*S*)-hydroperoxyoctadecadienoic acid as substrate. The products of 12-epoxidation are labile, and the epoxide ring is hydrolytically cleaved into corresponding trihydroxy compounds. On the other hand, OsPXG9 catalyzed 15-epoxidation of 13(*S*)-hydroperoxyoctadecatrienoic acid generates a relatively stable epoxide product. Therefore, the regiospecific 12- or 15-epoxidation catalyzed by OsPXG9 strongly depends on activation of the 9- or 13-peroxygenase reaction pathways, with their respective preferred substrates. The relative abundance of products in the 9-PXG and 13-PXG pathways suggest that the 12-epoxidation involves intramolecular oxygen transfer while the 15-epoxidation can proceed *via* intramolecular or intermolecular oxygen transfer. Expression of *OsPXG9* is up-regulated by abiotic stimuli such as drought and salt stress, but it is down-regulated by biotic stimuli such as flagellin 22 and salicylic acid. The results suggest that the primary function of OsPXG9 is to modulate the level of lipid peroxides to facilitate effective defense responses to abiotic and biotic stressors.

P-71

SCR7 treatment for CRISPR/Cas9-mediated knock-in reduces expression of the Msh2 gene in mouse mammary epithelial cells

Kim GY[1], You HJ[1], Lee GC[1], Kang MJ[1]

[1]Division of Animal Science, College of Agriculture and Life Sciences, Chonnam National University, Gwangju, Korea

ABSTRACT

DNA double-strand breaks caused by CRISPR/Cas9(Clustered regularly interspaced short palindromic repeats-associated protein9) can be repaired by homologous recombination (HR) and non-homologous end-joining (NHEJ). HR can precisely introduce foreign genes into the target genome locus. Therefore, it is necessary to study the HR-related DNA repair pathway. The purpose of this study is to investigate the effect of RS-1 and SCR7 treatment on the expression of MMR (mismatch repair pathway)-Msh2 gene which is inextricably related to HR. The knock-in vector and sgRNA were introduced into HC11 cells and treated with 7.5uM RS-1, 40uM SCR7, and a combination of RS-1 and SCR7. As a result, the knock-in efficiency increased by about 6% for RS-1, about 12% for SCR7, and about 9% for the combination of RS-1 and SCR7 compared with the group not treated compound. But there was no significant difference. The mRNA expression of the Msh2 gene following RS-1 and SCR7 treatment during CRISPR/Cas9-mediated knock-in in HC11 cells was analyzed by qRT-PCR. As a result, 7.5uM RS-1 treatment increased the Msh2 gene mRNA expression by about 10% compared to the group not treated with the compound, but there was no significant difference. However, 40uM SCR7 or a combination of RS-1 and SCR7 treatment reduced the Msh2 mRNA expression by about 40% compared to the non-compound treated($p<0.0001$). This result suggests that the Msh2 gene is more involved in NHEJ than HR. In addition, it is thought that it is necessary to investigate the interaction between Ligase IV and Msh2 gene.

P-72

Four Undescribed Fungal Species Belonging to Amphisphaeriales and Eurotiales in Korea

Ki Hyun Kang and Hyang Burm Lee*

Environmental Microbiology Lab, Dept. of Agricultural Biological Chemistry, College of Agriculture & Life Science, Chonnam National University, Gwangju 61186, Korea.

ABSTRACT

In the course of studying fungal diversity in soil and fresh water, four undescribed species belonging to Amphisphaeriales and Eurotiales were discovered. Based on the morphological characteristics and sequence analyses of the internal transcribed spacer (ITS), beta-tubulin (BenA), calmodulin (CaM) and partial translation elongation factor 1-α gene (tef1), the strains of CNUFC HS10, CNUFC YJ36, CNUFC SC9 and CNUFC YB6 were identified as *Pestalotiopsis neolitseae, Neopestalotiopsis maddoxii, Aspergillus fijiensis* and *Aspergillus uvarum,* respectively. To the best of our knowledge, these species have not been previously recorded in Korea.

P-73

Taxonomic and Phylogenetic Study on Genus *Mucor* Isolated from Invertebrates Collected in Cheongyang, Korea

Thuong T. T. Nguyen and Hyang Burm Lee*

Environmental Microbiology Lab, Dept. of Agricultural Biological Chemistry, College of Agriculture & Life Science, Chonnam National University, Gwangju 61186, Korea.

ABSTRACT

The genus *Mucor* is classified in the family Mucoraceae, order Mucorales, and phylum Mucoromycota, which belongs to the early diverging fungal lineage. With more than 90 currently accepted species, *Mucor* is the largest genus within Mucorales. Species of *Mucor* are known to be saprotrophs that are usually isolated from soil. Some species have important industrial applications because of their ability to produce a wide range of metabolites and enzymes, others are human pathogens causing mucormycosis. In Korea, about 30 species of this genus which have been described. Thus, more *Mucor* species need to be still surveyed in Korea. The aim of this study was to explore the taxonomy and phylogeny of genus *Mucor* from invertebrates samples collected at Cheongyang in the Chungnam Province of Korea. A total of 25 isolates were obtained. The isolates were identified based on phenotypic characters and ITS and LSU sequence analyses. Results from the analyses showed that five species were represented as new species, two as new records, and one as new host record. Detailed morphological descriptions and phylogenetic status of *Mucor* spp. from invertebrates are provided in the poster.

P-74

Optimization of tomato transformation with protoplast extraction and regeneration

So Hee Yang*, Euyeon Kim, Hyosun Park, Yeonjong Koo
Department of Agricultural Chemistry, Chonnam National University, Gwangju, Republic of Korea

ABSTRACT

The cellular regeneration of protoplasts is used in plant genetic engineering and genome editing. the regeneration of tomato transgenic plants through the protoplast transient expression and regeneration is not introduced as a regular method yet because the traditional Agrobacterium method is dominantly applied for its high efficiency. However, the necessity of introducing the protoplast method is increasing for commercial applications. Therefore, in this study, we are trying to introduce the CRISPR-Cas9 system into the protoplasts in various ways PEG with DNA, vesicles harboring RNP, and electroporation with RNP to develop high efficient CRISPR/Cas9 expression and gene edition. First of all, we optimized the tomato protoplast isolation condition for high recovery of protoplasts and efficiency for transient assay. The gene edition efficiency of CRISPR/Cas9 in protoplast was higher than that in the Agrobacterium-mediated transient expression. The efficiency of transient expression in the tomato protoplast was also measured by Green fluorescent protein expression in the isolated protoplasts. The tomato protoplast regeneration method developed in this study is expected to provide an efficient gene editing of tomatoes and an opportunity for basic research on tissue regeneration.

P-75

Biocontrol of *Fusarium* head blight by endophytic bacterium NS2 in rice

Yujeong Yeo

Department of Agricultural Chemistry, Institute of Environmentally Friendly Agriculture, College of Agriculture and Life Science, Chonnam National University, 77 Yongbong-Ro, Gwangju, 61186, Republic of Korea

ABSTRACT

Fusarium head blight (FHB), caused by several species of *Fusarium,* including *F. graminearum* and *F. asiaticum*, is a devastating disease in wheat, barley, rice, and other cereal crops worldwide. In addition to extensive damage through direct losses in yield and quality due to damaged *Fusarium* kernels, the pathogens also produce mycotoxins, such as trichothecenes and zearalenone, that are harmful to animals and humans. For decades, chemical fungicides have been used to control FHB due to their convenience and high control efficacy. However, the prolonged usage of chemical fungicides has caused adverse effects such as the emergence of drug resistance in pathogens and environmental pollution. In this study, the endophytic bacterium NS2 was isolated from rice and was selected as an environmentally friendly alternative to chemical fungicide for managing FHB. The bacterial strain NS2 exhibited broad-spectrum antagonistic activity against various phytopathogenic fungi and produced iturin A and surfactin as active antifungal compounds. Furthermore, we confirmed that the endophytic bacterial strain NS2 caused the expression of the *PR1* gene, known as induced resistance activity, using transgenic *Arabidopsis* plants expressing the β-glucuronidase (GUS) fused with the *PR1* gene promoter. In a greenhouse experiment, the culture broth and the suspension concentrate type formulation of the bacterial strain NS2, at 1,000-fold dilution, effectively suppressed the development of FHB. These results suggest that the endophytic bacterial strain NS2 has the potential as a new biological control agent for the control of FHB.

Keywords: *Fusarium* head blight, Antifungal activity, Induced resistance, Endophytic bacterium

P-76

Actinomycete Strain S34-4 as a Potential Biocontrol Agent Acting by Two Mechanisms: Antibiosis and Induced Resistance

Loan Thi Thanh Nguyen

Department of Agricultural Chemistry, Institute of Environmentally Friendly Agriculture, College of Agriculture and Life Science, Chonnam National University, 77 Yongbong-Ro, Gwangju, 61186, Republic of Korea

ABSTRACT

A strain S34-4 that produces secondary metabolites with highly potent antibacterial activity was isolated from a soil sample from Buan, South Korea. S34-4 was identified as an actinomycete by molecular characterization. In this study, two active metabolites of actinomycete strain S34-4 were purified by bioassay-guided fractionation against *Erwinia amylovora* and instrumental analysis, such as thin layer chromatography and column chromatography techniques. S34-4 culture filtrate and two active metabolites had a broad spectrum against various phytopathogenic bacteria and fungi. Among the various media used to maximize the production of the active antimicrobial metabolites, S34-4 produced two metabolites the most from TSB. Using a Placket-Burman experimental design to aid in the first step of optimization, tryptone, peptone, pH, inoculum size, and incubation time were significant factors affecting the production of two active metabolites. S34-4 culture filtrate and its metabolites showed high disease efficacy with preventative and curative activity against tomato bacterial wilt caused by *Ralstonia solanacearum in vivo.* The pretreatment of S34-4 culture filtrate also suppressed the outbreak of Fusarium head blight in rice caused by *Fusarium asiaticum* by induced resistance. Moreover, the seeds coated with S34-4 stain showed excellent disease efficacy against Kimchi cabbage soft rot caused by *Pectobacterium carotovorum* subsp. *carotovorum*. Especially two formulations of actinomycete strain S34-4 (freeze-dried S34-4 culture broth wettable powder and S34-4 ethyl acetate layer wettable powder) had high disease efficacy against fire blight in apple seedlings via antibacterial action and induced resistance. Conclusionally, these results suggest that actinomycete strain S34-4 manages various plant diseases with two distinct mechanisms: antibiosis and induced resistance, and can be utilized as a biocontrol agent for controlling broad plant pathogens.

Keywords: Antimicrobial agent, Actinomycete, Fire blight, Seed coating, Induced resistance

P-77

Screening for Potential Antibacterial Agents from Soil Microorganisms against Fire Blight Caused by *Erwinia amylovora*

Loan Thi Thanh Nguyen

Department of Agricultural Chemistry, Institute of Environmentally Friendly Agriculture, College of Agriculture and Life Science, Chonnam National University, 77 Yongbong-Ro, Gwangju, 61186, Republic of Korea

ABSTRACT

Fire blight, caused by *Erwinia amylovora*, is a fatal bacterial disease on plants in the rose family, such as apple, pear, loquat, and pyracantha. Even using synthetic pesticides and antibiotic agents, controlling fire blight diseases in plants is difficult. Consequently, the overuse of these chemicals for disease control has led to significant environmental pollution, human health risks, and the induction of antibiotic-resistance pathogens. To solve these issues, biopesticides such as microbial pesticides have emerged as potential alternatives. The rhizosphere soil with microbial diversity is regarded as an inexhaustible resource for developing biopesticides. In our study, 110 soil samples were collected from various regions in Korea, and 418 bacterial strains were isolated. Seven strains showed antibacterial activity against *Erwinia amylovora* TS3128, which caused apple fire blight. These seven bacterial strains were identified as actinomycetes through basic growth, biochemical properties, spore morphology, and 16S rRNA sequencing. The antimicrobial activity of these seven actinomycetes was assayed against various plant pathogenic bacteria and fungi. Four resistance-inducing active strains (S19-1-2, S22-22, S34-4, and S72-2) were selected using the transgenic *Arabidopsis thaliana* line (*PR1 pro::GUS*) to investigate the resistance-inducing activity-related salicylic acid signaling pathway. Seeds treated with these four strains showed excellent activity against tomato bacterial wilt caused by *Ralstonia solanacearum* SL341 *in vivo*. In addition, the induced resistance caused by pretreatment of S19-1-2 and S34-4 through soil drenching effectively suppressed the bacterial wilt incidence in tomatoes and controlled apple fire blight caused by *Erwinia amylovora* TS3128 *in vivo*. Thus, actinomycetes S19-1-2 and S34-4 could be potential candidates for developing biopesticides to control various plant bacterial diseases, including fire blight, via two distinct mechanisms: antibiosis and induced resistance.

Keywords: Fire blight, Biopesticide, Actinomycetes, Induced resistance

P-78

Biocontrol efficacy of *Streptomyces lydicus* JCK-6019 producing natamycin against soil-born fungal diseases

Feng Luo

Department of Agricultural Chemistry, Institute of Environmentally Friendly Agriculture, College of Agriculture and Life Science, Chonnam National University, 77 Yongbong-Ro, Gwangju, 61186, Republic of Korea

ABSTRACT

Soil-borne fungal pathogens cause huge economic losses to farms by reducing crop productivity and quality. For decades, chemical fungicides have been used to control these pathogens due to their convenience and high control efficacy. However, chemical fungicides have caused adverse effects such as the emergence of drug resistance in pathogens and environmental pollution. In this study, *Streptomyces lydicus* JCK-6019 was isolated from rhizosphere soil and was selected as an environmentally friendly alternative to chemical fungicides for managing soil-borne fungal diseases. JCK-6019 exhibited broad-spectrum antagonistic activity against various phytopathogenic fungi. The fermentation filtrate of JCK-6019 inhibited the growth of fungi with minimum concentration inhibitory (MIC) values of 0.078–10%. The volatile organic compound test showed that JCK-6019 fermentation broth inhibited the growth of pathogenic fungi mycelia with inhibition values of 35.28-93.05%. *S. lydicus* JCK-6019 produced natamycin as an active antifungal compound and a variety of hydrolytic enzymes, such as cellulase, protease, gelatinase, and chitinase. When transgenic *Arabidopsis thaliana* seedlings, including *PR1 promoter::GUS* vector, were treated with the fermentation broth of JCK-6019, *GUS* gene was expressed, indicating that *S. lydicus* JCK-6019 application has induced systemic resistance in plants and concurrently antifungal activity against various phytopathogenic fungi. Treatment with fermentation broth or BuOH extract WP20 formulation of JCK-6019 effectively suppressed the development of cucumber fusarium wilt, cucumber damping-off, and creeping bentgrass dollar spot by induced resistance and antifungal activity *in vivo* experiments. These results suggest that *S. lydicus* JCK-6019 could be effectively used to develop biological control agents for soil-borne plant diseases.

Keywords: Action mechanism, Soil-borne fungal pathogen, Antifungal activity, Induced resistance, Natamycin

P-79

벼 생육기간 동안 타워에 설치된 기기에서 관측된 태양 유도엽록소 형광의 4년 관측자료: 나주와 김제

조은이[1,2], 문현동[1,2], 심교문[3], 이경도[3], 류재현[3], 염종민[4], 하종성[4], 조재일[1,2]

[1]전남대학교 응용식물학과

[2]전남대학교 IT-Bio 융합시스템농업교육연구단

[3]국립농업과학원 기후변화평가과, [4]한국항공우주연구원 국가위성정보활용지원센터

초록

식물에 흡수된 광합성유효복사광 에너지 일부가 광합성 명반응(광인산화반응)에 이용되지 못하고 650~800 nm 파장대 에너지로 손실된 것이 엽록소 형광이며, 이는 엽록소에 입력된 태양광 에너지량과 광합성 효율 관련 생리장해에 따라 달라진다. 엽록소 형광은 광합성 효율 관련 작물 스트레스 탐지에 유용하지만, 야외 기상환경에 노출되어 있는 작물은 일사 조건이 일정하지 않아 식물 광합성 효율을 분석하기 어렵다. 태양 유도 엽록소 형광(Sun-induced Fluorescence, SIF) 관측은 노지에서 식물의 엽록소 형광을 평가하는 동시에 총일차생산량 (Gross Primary Production, GPP)의 대리지표로 주목받고 있다. 하지만 충 분한 SIF 자료기반의 연구 및 분석 사례는 국내외적으로도 드물다. 이에 본 연구진은 선도적으로 논벼에서 SIF 자료를 구축하고 있다. 관측기기로는 650~880 nm 파장 대역을 0.17 nm 간격으로 샘플링하여 0.3 nm의 분광해상도로 SIF를 산출할 수 있는 JB Hyperspectral Devices사의 FloX 제품을 이용하였다. 태양 복사조도를 관측하는 프로브는 180°, 식생 복사휘도 관측은 20°의 시야각을 가지며 지면을 수직(Nadir)으로 바라보게 설치했다. 관측은 매일 오전 6시부터 오후 6시까지 12시간 동안 1~2분 간격으로 집록하고 있으며, SIF 계산법으로는 Improved Fraunhofer line depth (iFLD), Spectral Fitting Method (SFM)와 Singular Value Decomposition (SVD)를 사용하였다. 나주시 전남농업기술원 논에 위치한 RNK01 사이트에서 2020년, RNK02 사이트에서 2021년과 2022년, 그리고 김제시 논 사이트에서 2022년, 이렇게 4년의 논벼 SIF 자료가 수집되었다. 이는 각 사이트의 미기상 자료, 에디공분산 기반의 GPP, 다양한 식생지수(들)와 융합 및 분석되어 스마트 벼 재배와 안정적 생산량 예측에 기여할 것으로 기대한다.

P-80

이동형 2방향 고니오미터 장착 초분광계를 이용한식생지표면의 이방성 반사도 특성 분석

문현동[1,2*], 김현기[1,2], 조유나[1,2], 조은이[1,2], 김보경[1,2], 이유현[1], 이예진[1], 류재현[3], 안호용[3], 이경도[3], 조재일[1,2]

[1]전남대학교 응용식물학과
[2]IT-Bio 융합시스템농업교육연구단
[3]국립농업과학원 기후변화평가과

초록

식생지표면 반사도는 시야 및 광원 방향의 함수인 이방성(Anisotropy) 특성을 갖기 때문에 표면의 방사 조도 기하학과 센서의 시야각 사이 관계를 설명하는 양방향 반사 분포 함수(Bidirectional Reflectance Distribution Function, BRDF) 개념이 원격탐사기법으로 관측한 표면 반사도를 보정하는데 필요하다. 실험자가 의도한 각도로 분광계가 지표반사도를 측정할 수 있게 해주는 고니오미터(Goniometer, 각도조정기)는 다양한 지표면의 BRDF 연구에 사용되어왔다. 본 연구에서는 식생 표면의 이방성 반사도 특성을 이해하여 BRDF 보정 및 평가에 이용하고자 360도 전방향의 기본 타입에서 2방향(좌/우)으로 간략화한 이동형 고니오미터를 제작하여 사용하였다. 고니오미터에 설치된 분광계는 JB Hyperspectral Devices사의 RoX 제품으로써 400~950 nm 범위 파장에서 입사(Irradiance)와 반사(Reflectance) 방사값을 관측하며 0.65 nm 간격의 분광 샘플 수집, 그리고 입사와 반사 관측 탐침의 시야각(Field of View)이 각각 180°와 20°이다. 반사 탐침(Downward looking proble)는 수직방향(Nadir) 관측 기준 188cm 높이에 설치되었다. 태양천정각(Solar Zenith Angle)이 가장 작은 정오 시간인 12~13시에 전남대학교 광주캠퍼스의 1층 건물 옥상에서 센서 각도를 지표면 기준 40°, 65°, 90°, 115°, 140°로 3%, 25%, 35%, 53% 반사도 보정천을 측정하였다. 그리고 논벼 군락의 반사도를 오전 10시, 오후 12시, 오후 15시에 보정천 관측과 동일한 각도로 총 3회씩 반복 측정하였다. 본 연구에서 사용한 고니오미터는 다양한 식생 표면의 BRDF 보정 반사율 평가와 검증에 유용할 것으로 기대한다.

P-81

A *Panax ginseng* R2R3 MYB transcription factor *PgMYB123*, regulates proanthocyanidin biosynthesis in *Arabidopsis thaliana* when overexpressed

David Charles Simiyu[1,2,3], and Ok Ran Lee[1,2*]

[1]Department of Applied Plant Science, College of Agriculture and Life Science, Chonnam National University, Gwangju, 61186, Republic of Korea

[2]Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju, 61186, Republic of Korea

[3]Botany Department, College of Natural and Applied Sciences, University of Dar es Salaam, Dar es Salaam, Tanzania

ABSTRACT

Proanthocyanidins (PAs) are flavonoids with important defensive roles against biotic, and abiotic stress in plants. The compounds are also used extensively by humans in various industries including cosmetics, pharmaceuticals, food, and beverages. Molecular regulation of PA biosynthesis has been extensively studied in other plants such as tobacco, and *Arabidopsis thaliana*. But in a high-value medicinal plant *Panax ginseng*, PA biosynthesis regulation remains unknown. Here, we report that PA biosynthesis in *P. ginseng* is mediated by a R2R3 MYB transcription factor *PgMYB123.* Phylogenetic analysis clusters *PgMYB123* with PA biosynthesis transcription factors from other plants including *AtMYB123/TT2* from *A. thaliana*. *PgMYB123* was localized in the nucleus of the cell, indicating its role as a transcription factor. When overexpressed in *A. thaliana*, *PgMYB123* led to an increased PAs accumulation in siliques, and in mature seeds. Additionally, transcript level analysis in *PgMYB123*-overexpressing transgenic *A. thaliana* plants, showed upregulation of the structural genes involved in PA biosynthesis. Together, these results indicate *PgMYB123* codes for a protein that activates the genes involved in PA biosynthesis.

P-82

방사무늬김(*Pyropia yezoensis*)과 잇바디돌김(*Pyropia dentata*)의 성분학적 특성 비교

송시훈[1*], 최진혁[1], 김형균[2], 정재천[2], 조정용[1]
[1]전남대학교 식품공학과, [2]목포수산식품지원센터

ABSTRACT

김 (*Pyropia* spp.)은 홍조류에 속하는 대표적인 해조류로, 한국, 중국, 일본에서 주로 소비되고 있으며 최근 유럽, 미국 등의 서양에서도 기호식품으로 그 소비가 증가하고 있는 추세이다. 김에는 다당류, 단백질, 무기질, 비타민, mycosprorine-like amino acid류(MAA), 그리고 고도불포화지방산 등의 유용성분을 함유하고 있다. 이러한 성분 함량은 품종 및 재배환경에 따라 큰 차이가 있다. 방사무늬김과 잇바디돌김은 우리나라에서 널리 소비되고 있으나 이들 품종의 품질 관리를 위한 성분학적 연구는 미흡한 실정이다. 그래서, 본 연구에서는 시중에 판매되고 있는 44종의 방사무늬김과 잇바디돌김를 대상으로 대사체 및 다변량 통계 분석을 통해 성분학적 특성을 파악하고자 하였다. UPLC-ESI-Q-TOF-MS를 이용하여 김 대사체 분석을 실시한 한 다음 OPLS-DA를 분석한 결과, 두 품종은 확연하게 구별됨을 확인할 수 있었다. 두 품종을 구별하는 주요 성분들은 현재 동정 중에 있다. 또한, 김의 대표적인 MAA인 shinorine과 porphyra-334를 LC-MS를 이용하여 정량하였다. 그 결과, 두 성분 모두 방사무늬김에 비해 잇바디돌김에서 높은 함량이었으며, 특히 shinorine의 함량은 잇바디돌김이 방사무늬김 보다 월등히 높았다. 방사무늬김과 잇바디돌김의 구성 아미노산 함량은 거의 유사하였으며, 이 중 glutamic acid, alanine, aspartic acid는 주요 구성 아미노산임을 알 수 있었다. 구성 아미노산 함량에 대한 PLS-DA 결과, 두 품종이 구별되고, valine, glycine, proline, isoleucine, threonine, leucine이 두 품종을 구별하는 주요아미노산임을 확인하였다.

전남대학교 농업생명과학대학

College of Agriculture and Life Sciences Chonnam National University