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DESCRIPTION KR102476316B1

Method for increasing ferulic acid productivity of *Lemna paucicostata*

좀개구리밥의 페룰산 생산 증진방법{Method for increasing ferulic acid productivity of *Lemna paucicostata*}

[0001]

[The present invention relates to a method for increasing ferulic acid production of a frog's moss using ethephon and a medium additive for cultivating a frog's moss.]

[본 발명은 에테폰을 이용하여 좀개구리밥의 페룰산 생산을 증가시키는 방법 및 좀개구리밥 배양용 배지첨가제에 관한 것이다.]

[0002]

Lemna minor, also known as Lemna paucicostata, is a fast-growing, easy-to-harvest, non-toxic plant in the Araceae family. Containing 43% protein by dry weight, it has been used as a natural source of protein. It can be easily harvested by simply floating it on the surface of the water, and is used as fish food that does not require further processing and as a raw material for producing antipyretics and analgesics.]

[좀개구리밥 (Lemna paucicostata)으로 알려진 렘나(Lemna minor)과는 천남성과(Araceae)에 속하고, 빠르게 자라며 쉽게 수확될 수 있으며 무독성 식물이다. 건조 중량에서 43%의 단백질을 함유하고 있어 자연적 단백질의 원천으로 사용되어 왔으며, 수면 위를 떠내는 것만으로도 쉽게 수확할 수 있는 좀개구리밥은 추가 가공이 필요 없는 물고기의 먹이이고 해열 및 진통제 생산의 원료이다.]

[0003]

[In addition, the floating effect of duckweed in the light required for algae growth can remove chromium (Cr;Vi) from industrial wastewater and was used to evaluate the toxicity of propanil (3,4-dichloropropionanilide).

[또한, 조류의 성장에 필요한 빛에 있어서 좀개구리밥의 부유 효과는 공장폐수로부터 크롬(Cr;Vi)을 제거할 수 있으며, 프로파닐(3,4-디클로로프로피오나닐라이드)의 독성을 평가에 사용되었다.

The pectin polysaccharide of the above plant is called lemnan and is known to increase phagocytosis and exhibit immunomodulatory activity.]

상기 식물의 펙틴질의 폴리사카라이드는 렘난(lemnan)으로 불려졌고, 식세포작용을 증가시키고 면역조절 효과 활성을 나타낸다고 알려졌다.]

[0004]

[The Lemnaceae species, which contain high concentrations of inexpensive proteins, starches and fatty acids, are already used in the food industry in foods such as soups, curries and salads, and are widely used traditionally in China, Russia and some European countries as an analgesic, anthelmintic and anti-inflammatory agent to treat diseases of the throat and nose.

[고농도의 저렴한 단백질, 전분 및 지방산을 함유한 렘나과 종은 이미 식품 산업, 수프, 카레 및 샐러드와 같은 식품에 사용되고 있으며, 중국, 러시아 및 일부 유럽 국가에서 전통적으로 진통제, 구충제 및 항염증제로 인후 및 코 질환 치료에 널리 사용되고 있다.

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[0005]

[Meanwhile, in animals, gamma-aminobutyric acid (GABA) is known as a neurotransmitter in the central nervous system, and in plants, it acts on cell signaling and accumulates in response to environmental stress.

[한편, 동물에 있어서, 가바 (gamma-aminobutyric acid, GABA)는 중추신경 시스템의 신경전달물질로 알려져있으며, 식물에서는 세포 신호전달에 작용하고, 환경 스트레스에 반응하여 축적된다.

These GABAs are used as relaxants and hormone regulators in the treatment of insomnia, narcolepsy, and epilepsy.]

이러한 가바는 불면증, 기면증 및 뇌전증 치료에 있어서, 이완 및 호르몬 조절자로 사용된다.]

[0006]

[Also, ferulic acid is a natural phenol known to play an important role in antioxidant activity.

[또한, 페룰산(ferulic acid)은 천연 페놀로 항산화에 중요한 역할을 하는 것으로 알려졌다.

According to previous reports, phenolic acid extracted from *Tetragonia tetragonioides* exhibited whitening and wrinkle improvement effects, and when ferulic acid was treated together with ascorbic acid and α -tocopherol in the epidermis, it was confirmed to induce thymine dimer formation and inhibition of ROS. Therefore, research is ongoing to mass-produce GABA and ferulic acid, which exhibit physiological activity, in a safe and easy way for the human body for industrial use.]

앞선 보고에 따르면, 번행초 (*Tetragonia tetragonioides*)에서 추출된 페놀산은 미백 및 주름 개선 효과를 나타내었으며, 표피에서 페룰산을 아스코르브산 및 α -토코페롤과 병용처리할 경우, 티민이량체 형성 및 ROS의 저해를 유도하는 것으로 확인됨에 따라, 생리 활성을 나타내는 가바 및 페룰산을 산업적으로 이용하기 위해 인체에 안전하고 손쉬운 방법으로 대량생산하기 위한 연구가 계속 진행되고 있다.]

[0007]

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공개))]]

[0008]

[The present invention aims to provide a method for cultivating a small frog's moss with increased ferulic acid and GABA contents using ethephon and a medium additive for cultivating a small frog's moss.

[본 발명은 에테폰을 이용하여 페룰산과 가바 함량이 증가된 쯤개구리밥 배양 방법 및 쯤개구리밥 배양을 위한 배지첨가제를 제공하고자 한다.

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[0009]

[The present invention provides a cultivation method for enhancing ferulic acid production of a Korean dwarf frog, which comprises a step of cultivating a Korean dwarf frog in a medium containing ethephon as an active ingredient.

[본 발명은 에테폰을 유효성분으로 함유하는 배지에서 좀개구리밥을 배양하는 단계를 포함하는 좀개구리밥의 페룰산 생산 증진용 배양방법을 제공한다.

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[0010]

[The present invention provides a medium additive for increasing the ferulic acid content of a frog's moss, containing ethephon as an effective ingredient.

[본 발명은 에테폰을 유효성분으로 함유하며, 좀개구리밥의 페룰산 함량 증진용 배지첨가제를 제공한다.

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[0011]

[In addition, the present invention provides a frog plant cultured in a medium containing ethephon as an active ingredient and having an increased ferulic acid content.

[또한, 본 발명은 에테폰을 유효성분으로 함유하는 배지에서 배양되며, 페룰산 함량이 증가된 좀개구리밥 식물체를 제공한다.

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[0012]

[According to the present invention, the number of leaves of the duckweed cultured in a medium containing ethephon was increased compared to the control group, and the production of ferulic acid and GABA was confirmed to be increased. Therefore, the method for culturing duckweed through ethephon treatment can be provided as a method for mass-producing ferulic acid and GABA that can be used industrially, and the composition containing ethephon can be provided as a medium additive for increasing the ferulic acid and GABA content of the duckweed.

[본 발명에 따르면, 에테폰이 포함된 배지에서 배양된 좀개구리밥은 대조군과 비교하여 좀개구리밥의 잎수가 증가하였으며, 페룰산 및 가바 생산량이 증가된 것으로 확인됨에 따라, 상기 에테폰 처리를 통한 좀개구리밥 배양 방법은 산업적으로 이용가능한 페룰산 및 가바 대량생산 방법으로 제공될 수 있으며, 에테폰을 포함하는 조성물은 좀개구리밥의 페룰산 및 가바 함량 증진용 배지첨가제로 제공될 수 있다.

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[0013]

[Figure 1 shows the results of confirming the effect of various ethephon concentrations on the total dry weight of the Korean water parsley. In each treatment group, the vertical bar represents the mean value, and the error bar represents the standard deviation (n = 3).

[도 1은 쯤개구리밥의 총 건조 중량에 있어서, 다양한 에테폰 농도가 미치는 영향을 확인한 결과로, 각 처리군에서 세로 막대는 평균값으로 나타내었으며, 오차 막대는 표준편차로 나타내었다 (n = 3).

Asterisk (*) indicates a significant difference between the control and treatment groups ($p < 0.05$).

별표(*)는 대조군과 처리군 간의 유의적인 차이를 나타낸다 ($p < 0.05$).

Figure 2 shows the results of confirming the total number of leaves of the *Dendrobium japonica* cultured under various concentrations of ethephon treatment. The results are expressed as an average value, and the vertical bars represent the standard deviation from three biological replicates.

도 2는 다양한 농도의 에테폰 처리하에서 배양된 좀개구리밥의 총 잎수를 확인한 결과로, 결과값은 평균값으로 나타내었으며, 세로 막대는 세 가지 생물학적 복제에서 표준편차를 나타낸다.

Figure 3 shows the relative levels of major metabolites of the duckweed cultured for 35 days under various ethephon concentration conditions, and shows the proposed metabolite pathways according to the KEGG database (<http://www.genome.jp/kegg/>). The results are the mean and the error bars represent the standard deviation (SD) of nine measurements ($n = 9$, three biological replicates and three technical replicates).

도 3은 다양한 에테폰 농도 조건에서 35일 배양된 좀개구리밥의 주요 대사산물의 상대적 수준을 확인한 결과로, KEGG database (<http://www.genome.jp/kegg/>)에 따라 제안된 대사산물의 경로를 나타낸 것으로, 결과값은 평균이며 오차 막대는 9개의 측정값의 표준편차(SD)를 나타낸다 ($n = 9$, 3 개의 생물학적 복제 및 3 개의 기술적 복제).

Mann-Whitney test ($p < 0.05$) was performed to confirm significant differences between the control group and ethephon treatment group, and significant differences in each ethephon treatment group are indicated by asterisks.

Mann-Whitney test ($p < 0.05$)를 수행하여 대조군과 에테폰 처리군 간의 유의적인 차이를 확인하였으며, 각 에테폰 처리군의 유의적 차이를 별표로 나타내었다.

Figure 4 shows the results of the score plot derived by PCA including quality control (QC) samples, in which the ethephon treatment groups and quality control (QC) at concentrations of 0.05, 0.1, 0.2, 0.5, and 1 mM are indicated by ○, ■, ▲, ▼, ◆, ●, and ■, respectively.

도 4는 정도관리 (QC) 샘플을 포함하여 PCA에 의해 유도된 점수 플롯을 나타낸 결과로, 0.05, 0.1, 0.2, 0.5 및 1 mM 농도의 에테폰 처리군 및 정도관리 (QC)를 각각 ○, ■, ▲, ▼, ◆, ● 및 ■으로 나타내었다.

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[0014]

[Hereinafter, the present invention will be described in more detail.

[이하, 본 발명을 보다 상세하게 설명한다.

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[0016]

[The inventors of the present invention were conducting research to mass-produce GABA and ferulic acid, which exhibit excellent physiological activity in the human body, in a safe and easy way for industrial use, and they confirmed that the number of leaves of the duckweed cultured in a medium containing ethephon increased compared to the control group, and that the production of ferulic acid and GABA increased, thereby completing the present invention.

[본 발명의 발명자들은 인체에 우수한 생리 활성을 나타내는 가바 및 페룰산을 산업적으로 이용하기 위해 인체에 안전하고 손쉬운 방법으로 대량생산하기 위한 연구를 진행하던 중 에테폰이 포함된 배지에서 배양된 좀개구리밥은 대조군과 비교하여 좀개구리밥의 잎수가 증가하였으며, 페룰산 및 가바 생산량 증가를 확인함에 따라 본 발명을 완성하였다.

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[0018]

[The present invention can provide a cultivation method for enhancing ferulic acid production of *Lemna paucicostata*, which comprises a step of cultivating *Lemna paucicostata* in a medium containing ethephon as an active ingredient.

[본 발명은 에테폰을 유효성분으로 함유하는 배지에서 좀개구리밥을 배양하는 단계를 포함하는 좀개구리밥 (*Lemna paucicostata*)의 페룰산 생산 증진용 배양방법을 제공할 수 있다.

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]

[0019]

[The above ethephon may further enhance the production of gamma-aminobutyric acid (GABA) in the duckweed.

[상기 에테폰은 좀개구리밥의 가바 (gamma-aminobutyric acid, GABA) 생산을 추가로 더 증진시키는 것
일 수 있다.

]

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[0020]

[The above ethephon may be included in the medium at a concentration of 0.01 to 1 mM.

[상기 에테폰은 배지 중 0.01 내지 1 mM 농도로 포함되는 것일 수 있다.

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[0021]

[The above frog rice may be cultured in a medium containing ethephon for 7 to 40 days, more preferably, it may be cultured for 35 days, but is not limited thereto.

[상기 좀개구리밥은 에테폰이 함유된 배지에서 7 내지 40일동안 배양되는 것일 수 있으며, 보다 바람직하게는 35일간 배양되는 것일 수 있으나, 이에 제한되지 않는다.

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[0022]

[According to one embodiment of the present invention, 30 plants of the plant were placed in a 200 mL flask containing 100 mL of a medium containing ethephon at a concentration of 0,

0.05, 0.1, 0.2, 0.5 or 1 mM, and cultured. Samples were collected on the 35th day of culture to check the metabolite level. As a result, as shown in Table 4, the GABA production, which was at the level of 1.599 to 5.041 mg/L, was confirmed to be high at 5.041 ± 1.373 mg/L in the 0.5 mM ethephon treatment group, 3.394 ± 0.895 mg/L in the 0.2 mM ethephon treatment group, and 3.101 ± 0.808 mg/L in the 0.05 mM ethephon treatment group.

[본 발명의 일실시예에 따르면, 좁개구리밥을 0, 0.05, 0.1, 0.2, 0.5 또는 1 mM 농도의 에테폰이 첨가된 배지 100 mL이 포함된 200 mL 플라스크에 30 주(plants)씩 담아 배양한 후 배양 35일째에 시료를 수집하여 대사물질 수준을 확인한 결과, 표 4와 같이 1.599에서 5.041 mg/L 수준이었던 가바 생산량이 0.5 mM 에테폰 처리군에서 5.041 ± 1.373 mg/L, 0.2 mM 에테폰 처리군에서 3.394 ± 0.895 mg/L 및 0.05 mM 에테폰 처리군에서 3.101 ± 0.808 mg/L의 높은 가바(GABA) 생산이 확인되었다.

]

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[0023]

[In addition, the production of ferulic acid, which was at the level of 0.129 to 0.640 mg/L, was confirmed to be the highest in the 0.2 mM ethephon treatment group (0.640 ± 0.071 mg/L).

[또한, 0.129에서 0.640 mg/L 수준이었던 페룰산의 생산량은 0.2 mM 에테폰 처리군에서 가장 높은 생산량 (0.640 ± 0.071 mg/L)이 확인되었다.

]

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[0024]

[The present invention contains ethephon as an effective ingredient and can provide a medium additive for increasing the ferulic acid content of frog's moss.

[본 발명은 에테폰을 유효성분으로 함유하며, 좀개구리밥의 페룰산 함량 증진용 배지첨가제를 제공할 수 있다.

]

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[0025]

[The above-mentioned additive may further increase the GABA content of the frog rice.

[상기 배지첨가제는 좀개구리밥의 가바 함량을 추가로 더 증진시키는 것일 수 있다.

]

]

[0026]

[In addition, the present invention can provide a frog plant cultured in a medium containing ethephon as an effective ingredient and having an increased ferulic acid content.

[또한, 본 발명은 에테폰을 유효성분으로 함유하는 배지에서 배양되며, 페룰산 함량이 증가된 좀개구리밥 식물체를 제공할 수 있다.

]

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[0027]

[The above frog rice may have an additional increase in GABA content.

[상기 좀개구리밥은 가바 함량이 추가로 더 증가된 것일 수 있다.

]

]

[0029]

[Hereinafter, in order to help understand the present invention, examples will be given and described in detail.

[이하, 본 발명의 이해를 돕기 위하여 실시예를 들어 상세하게 설명하기로 한다.

However, the following examples are only intended to illustrate the content of the present invention and the scope of the present invention is not limited to the following examples.

다만 하기의 실시예는 본 발명의 내용을 예시하는 것일 뿐 본 발명의 범위가 하기 실시예에 한정되는 것은 아니다.

The embodiments of the present invention are provided to more completely explain the present invention to a person having average knowledge in the art.

본 발명의 실시예는 당업계에서 평균적인 지식을 가진 자에게 본 발명을 보다 완전하게 설명하기 위해 제공되는 것이다.

]

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[0031]

[<Experimental Example>]

[<실험예>]

[0032]

[The following experimental examples are intended to provide experimental examples commonly applied to each embodiment according to the present invention.

[하기의 실험예들은 본 발명에 따른 각각의 실시예에 공통적으로 적용되는 실험예를 제공하기 위한 것이다.

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[0034]

[U[attributes={}]; value=[1.

[U[attributes={}]; value=[1.

Cultivation of *Lemna paucicostata*]]]

좀개구리밥 (*Lemna paucicostata*) 배양]]]

[0035]

[*L. paucicostata* PC-10605 strain was obtained from the Korean Collection for Type Cultures (Biological Resource Center, Daejeon, Republic of Korea), and *L. paucicostata* was cultured on solid media according to a previously reported method (Biotechnol Bioprocess Eng.

[좀개구리밥 (*L. paucicostata*) PC-10605 균주를 Korean Collection for Type Cultures (Biological Resource Center, Daejeon, Republic of Korea)로 부터 얻었으며, 앞서 보고된 방법에 따라 고체 배지에 서 좀개구리밥을 배양하였다 (Biotechnol Bioprocess Eng.

2018;23: 23-30. doi:10.1007/s12257-017-0384-9).

2018;23: 23-30. doi:10.1007/s12257-017-0384-9).

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[0036]

[Subculture of the frog-shaped rice was performed every two weeks.

[좀개구리밥의 계대 배양은 2주마다 수행되었다.

To adapt to liquid medium conditions, the frog plant was cultured in 1 L of medium for 3 days.

액체 배지 조건에 대한 적응을 위해 좀개구리밥을 3일 동안 배지 1L에서 배양하였다.

After adaptation to the liquid medium, 30 plants were placed in 200 mL flasks containing 100 mL of medium containing various concentrations of ethephon.

액체 배지 적응 후, 다양한 농도의 에테폰이 첨가된 배지 100 mL이 포함된 200 mL 플라스크에 30 주 (plants)씩 담았다.

The experiment was repeated three times.

실험은 3회 반복 수행되었다.

Samples were collected on the 35th day of culture and lyophilized for 48 h (Bondiro, Ilshin Lab.

배양 35일째에 시료를 수집하여 48시간 동안 동결건조(Bondiro, Ilshin Lab. Co., Seoul, Republic of Korea) and stored at -75°C until analysis.

Co., Seoul, Republic of Korea)하고, 분석전까지 -75°C에 저장하였다.

]

]

[0038]

[U[attributes={}; value=[2.

[U[attributes={}; value=[2.

Growth measurement]]]

성장확인 (Growth measurement)]])

[0039]

[Ethephon was dissolved in the growth medium of the common frog plant at concentrations of 0.05, 0.1, 0.2, 0.5, or 1 mM, and the total number of leaves of the common frog plant was counted every 7 days.

[좀개구리밥 성장 배지에 에테폰을 0.05, 0.1, 0.2, 0.5 또는 1 mM 농도로 용해시켰으며, 좀개구리밥 잎의 전체 수를 7일마다 계수하였다.

To determine the total dry weight (DW), the collected whole plants were washed with distilled water and filtered under reduced pressure using Whatman filter paper (Whatman No. 2, Whatman, Maidstone, UK) and a pressure flask.

전체 건조 무게(DW)를 확인하기 위해, 수집된 전체 식물을 증류수로 세척하고 Whatman filter paper (Whatman No. 2, Whatman, Maidstone, UK)와 감압 플라스크를 이용하여 감압여과하였다.

Afterwards, it was dried for 15 minutes and transferred to a conical tube.

그 후 15분간 건조시키고 코니칼 튜브로 옮겨 담았다.

]

]

[0040]

[The total dry weight was checked after freeze-drying.

[동결 건조 후 전체 건조 무게를 확인하였다.

]

]

[0042]

[U[attributes={}]; value=[3.

[U[attributes={}]; value=[3.

GC-MS analysis for comprehensive metabolite profiling]]]

종합적인 대사산물 프로파일링을 위한 GC-MS 분석]]]

[0043]

[The samples were ground to perform gas chromatography-mass spectrometry (GC-MS) analysis.

[gas chromatography-mass spectrometry (GC-MS) 분석을 수행하기 위해 시료를 분쇄하였다.

The extraction method was performed according to the reported method (Kim et al., PLoS ONE. 2017;12:e0187622. doi:10.1371/journal.pone.0187622).

추출 방법은 보고되어진 방법(Kim et al., PLoS ONE. 2017;12:e0187622. doi:10.1371/journal.pone.0187622)으로 수행되었다.

]

]

[0044]

[10 µL of 2,000 mg/L myristic-d27 acid (Tokyo Chemical Industry Co., Japan) dissolved in pyrimidine was used as an internal standard (IS).

[내부 표준(IS)으로 미리스틱-d27 산 (Tokyo Chemical Industry Co., Japan) 2,000 mg/L의 10 µL를 피리미딘에 용해시켜 사용하였다.

]

]

[0045]

[GC-MS analysis conditions were previously reported (Nat Protoc.

[GC-MS 분석 조건은 이미 보고된 방법(Nat Protoc.

2006;1: 387-396. doi:10.1038/nprot.2006.59) was performed by changing the oven temperature setting.

2006;1: 387-396. doi:10.1038/nprot.2006.59)에서 오븐 온도 설정을 변경하여 수행하였다.

]

]

[0046]

[At the start of the experiment, the oven temperature was set to 60°C and was programmed to increase to 140°C (5°C/min), 150°C (10°C/min and held for 3 min), 180°C (3°C/min), 185°C (5°C

/min and held for 3 min), 200°C (3°C/min), 225°C (5°C/min), 230°C (3°C/min), 280°C (5°C/min), and finally to 310°C (8°C/min).

[실험 시작시 오븐 온도를 60°C로 설정하고 140°C (5°C/min), 150°C (10°C/min 및 3 min 유지), 180°C (3°C/min), 185°C (5°C/min 및 3 min 유지), 200°C (3°C/min), 225°C (5°C/min), 230°C (3°C/min), 280°C (5°C/min)까지 증가시켰으며, 마지막으로 310°C (8°C/min)까지 증가하도록 프로그래밍하였다.

The total running time was 59.42 minutes, and GC-MS analysis was performed three times.

총 실행시간은 59.42분이며, GC-MS 분석은 3회 수행되었다.

]

]

[0047]

[Spectral data including retention time and mass-to-charge ratio data of each peak were obtained from Expressionist MSX software (version 2013.0.39, Genedata, Switzerland) and converted to .csv format (Excel Office 2016).

[각 피크의 머무름 시간 및 질량 대 전하 비율 데이터가 포함된 스펙트럼 데이터를 Expressionist MSX software (version 2013.0.39, Genedata, Switzerland)에서 얻었으며, to.csv format (Excel Office 2016)으로 변환하였다.

]

]

[0048]

[The assignment of peaks obtained from GC-MS analysis was performed by matching the spectral data of each peak obtained from the sample with the spectral libraries of various databases.

[GC-MS 분석으로 얻은 피크의 할당은 다양한 데이터베이스의 스펙트럼 라이브러리와 샘플에서 얻은 각 피크의 스펙트럼 데이터를 매칭시켜 수행하였다.

]

]

[0049]

[70%

[70%

The peaks that matched the ideal were selected.

이상 일치되는 피크가 선택되었다.

Peak assignments were performed using the Golm Metabolome Database (gmd.mpimp-golm.mpg.de/), the Human Metabolome Database (HMDB), and the National Institute of Standards and Technology (NIST).

피크 할당은 Golm Metabolome Database (gmd.mpimp-golm.mpg.de/), Human Metabolome Database (HMDB) 및 National Institute of Standards and Technology (NIST)를 사용하여 수행되었다.

]

]

[0050]

[To determine the relative metabolite levels of each sample, peak normalization was performed by dividing the intensity of each peak by the intensity of the IS.

[각 샘플의 상대적인 대사 물질 수준을 확인하기 위해, 각 피크의 강도를 IS의 강도로 나누어 피크 표준화를 수행하였다.

]

]

[0052]

[U[attributes={}]; value=[4.

[U[attributes={}]; value=[4.

Quantification of GABA and ferulic acid]]]

가바 (GABA) 및 페룰산 (ferulic acid)의 정량]]]

[0053]

[Quantification of GABA, caffeic acid, and ferulic acid was performed with a calibration curve consisting of GABA standards (0.3125, 0.625, 1.25, 2.5, 5, 10, 20, 40, and 80 mg/L), caffeic acid standards (0.5, 1, 2, 4, 8, and 16 mg/L), and another curve for ferulic acid standards (0.5, 1, 2, 4, 8, and 16 mg/L).

[GABA, 카페인산 (caffeic acid) 및 페룰산의 정량을 GABA 표준 (0.3125, 0.625, 1.25, 2.5, 5, 10, 20, 40, and 80 mg/L), 카페인산 표준 (0.5, 1, 2, 4, 8, and 16 mg/L)으로 구성된 검량선과 페룰산 표준(0.5, 1, 2, 4, 8, and 16 mg/L)에 대한 다른 곡선으로 수행하였다.

]

]

[0054]

[A calibration curve was obtained by peak area ratio (each peak was divided by the IS peak area) and concentration.

[피크 영역 비율 (각 피크는 IS 피크 면적으로 나뉘어졌다) 및 농도로 검량선은 얻었다.

For the quantification of GABA, caffeic acid, and ferulic acid in the myristic-d27 acid, the same concentration of IS (2,000 mg/L myristic-d27 acid) was used.

좀개구리밥 내 GABA, 카페인산 및 페룰산의 정량을 위해, 동일한 IS (2,000 mg/L myristic-d27 acid)의 농도를 사용하였다.

By changing the oven temperature setting, the previously reported method (Nat Protoc.

오븐 온도 설정을 변경하여 이전에 보고된 방법(Nat Protoc.

2006;1: 387-396. doi:10.1038/nprot.2006.59) was used for quantitative analysis.

2006;1: 387-396. doi:10.1038/nprot.2006.59)으로 정량 분석을 수행하였다.

]

]

[0055]

[The starting oven temperature was set to 100°C and the temperature was increased to 150°C (5°C/min), 180°C (at 3°C/min), 185°C (5°C/min and held for 5 min), 200°C (3°C/min), 225°C (5°C/min) and 230°C (3°C/min).

[시작 오븐 온도를 100°C로 설정하고 150°C (5°C/min), 180°C (at 3°C/min), 185°C (5°C/min 및 5 min 유지), 200°C (3°C/ min), 225°C (5°C/min) 및 230°C (3°C/min)까지 온도를 증가시켰다.

]

]

[0056]

[GC-MS analyses of GABA, caffeic acid, and ferulic acid were performed three times.

[GABA, 카페인산 및 페룰산의 GC-MS 분석을 세번 반복하여 수행하였다.

]

]

[0057]

[The quantification of GABA, caffeic acid, and ferulic acid was performed using the regression equations in Table 1.

[GABA, 카페인산 및 페룰산의 정량은 표 1의 회귀방정식(regression equations)을 사용하여 수행하였다.

]

]

[0058]

[Table[attributes={}; value=[TableGroup[attributes={cols=5}; value=[colspec[attributes={align=left, colname=col1, colnum=1, colwidth=2925}; value=[]], colspec[attributes={align=center, colname=col2, colnum=2, colwidth=3013}; value=[]], colspec[attributes={align=center, colname=col3, colnum=3, colwidth=1762}; value=[]], colspec[attributes={align=center, colname=col4, colnum=4, colwidth=1875}; value=[]], colspec[attributes={align=center, colname=col5, colnum=5, colwidth=1909}; value=[]], TableBody[attributes={}; value=[Row[attributes={}; value=[Entry[attributes={align=left, colname=col1, valign=middle}; value=[B[attributes={}; value=[Compound]]]], Entry[attributes={align=center, colname=col2, valign=middle}; value=[B[attributes={}; value=[regression equation]]]], Entry[attributes={align=center, colname=col3, valign=middle}; value=[B[attributes={}; value=[R]], B[attributes={}; value=[Sup[attributes={}; value=[2]]]], B[attributes={}; value=[values]]]], Entry[attributes={align=center, colname=col4, valign=middle}; value=[B[attributes={}; value=[LOD (μg/mL)]]], Entry[attributes={align=center, colname=col5, valign=middle}; value=[B[attributes={}; value=[LOQ (μg/mL)]]]]], Row[attributes={}; value=[Entry[attributes={align=left, colname=col1, valign=middle}; value=[γ-Aminobutyric acid (GABA)]], Entry[attributes={align=center,

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value=[Row[attributes={}; value=[Entry[attributes={align=left, colname=col1, valign=middle}; value=[B[attributes={}; value=[Compound]]], Entry[attributes={align=center, colname=col2, valign=middle}; value=[B[attributes={}; value=[regression equation]]], Entry[attributes={align=center, colname=col3, valign=middle}; value=[B[attributes={}; value=[R]], B[attributes={}; value=[Sup[attributes={}; value=[2]]]], B[attributes={}; value=[values]]], Entry[attributes={align=center, colname=col4, valign=middle}; value=[B[attributes={}; value=[LOD (μg/mL)]]], Entry[attributes={align=center, colname=col5, valign=middle}; value=[B[attributes={}; value=[LOQ (μg/mL)]]]]], Row[attributes={}; value=[Entry[attributes={align=left, colname=col1, valign=middle}; value=[γ-Aminobutyric acid (GABA)], Entry[attributes={align=center, colname=col2, valign=middle}; value=[$y = 0.0293x - 0.0065$]], Entry[attributes={align=center, colname=col3, valign=middle}; value=[0.997]], Entry[attributes={align=center, colname=col4, valign=middle}; value=[0.64]], Entry[attributes={align=center, colname=col5, valign=middle}; value=[1.93]]], Row[attributes={}; value=[Entry[attributes={align=left, colname=col1, valign=middle}; value=[Caffeic acid], Entry[attributes={align=center, colname=col2, valign=middle}; value=[$y = 0.0164x - 0.0209$]], Entry[attributes={align=center, colname=col3, valign=middle}; value=[0.983]], Entry[attributes={align=center, colname=col4, valign=middle}; value=[0.05]], Entry[attributes={align=center, colname=col5, valign=middle}; value=[0.15]]], Row[attributes={}; value=[Entry[attributes={align=left, colname=col1, valign=middle}; value=[Ferulic acid], Entry[attributes={align=center, colname=col2, valign=middle}; value=[$y = 0.0053x - 0.0068$]], Entry[attributes={align=center, colname=col3, valign=middle}; value=[0.976]], Entry[attributes={align=center, colname=col4, valign=middle}; value=[0.22]], Entry

[0059]

[LOD, Limit of detection; LOQ, Limit of Quantitation.

[LOD, Limit of detection; LOQ, Limit of quantitation.

]

]

[0061]

[B[attributes={}; value=[<Example 1> Confirmation of growth of *L. paucicostata* according to ethephon treatment]]]

[B[attributes={}; value=<실시에 1> 에테폰 처리에 따른 좀개구리밥 (*L. paucicostata*) 성장 확인]]

[0062]

Whole plants of the plant were exposed to various concentrations of ethephon (0, 0.05, 0.1, 0.2, 0.5, or 1 mM).

[좀개구리밥 전초(Whole plant)를 다양한 농도 (0, 0.05, 0.1, 0.2, 0.5, or 1 mM)의 에테폰에 노출시켰다.

]

]

[0063]

[Referring to Figure 1, the total dry weight was reduced overall in all ethephon-treated groups compared to the control group.

[도 1을 참고하면, 대조군과 비교하여 모든 에테폰 처리군에서 총 건조중량이 전체적으로 감소하였다.

In more detail, the total dry weight was significantly reduced in all ethephon treatment groups except the 0.5 mM treatment group.

보다 상세하게 전체 건조중량은 0.5 mM 처리군을 제외한 모든 에테폰 처리군에서 유의하게 감소하였다.

]

]

[0064]

[In addition, as shown in Fig. 2, it was confirmed that the total number of leaves of the common frog plant increased under the treatment of 0.05 and 0.1 mM ethephon.

[또한, 도 2와 같이 0.05 및 0.1 mM 에테폰 처리하에서 좀개구리밥 잎의 전체 수가 증가된 것을 확인할 수 있었다.

]

]

[0065]

Depending on the plant species, tissue type, and concentration, ethylene affects growth, population size, or plant size.

[식물 종, 조직 타입 및 농도에 따라, 에틸렌은 성장, 개체 수 또는 식물 크기에 영향을 미친다.

For example, ethylene promotes growth in some aquatic plants, such as rice, while it inhibits growth in others, such as *Lemna minor*.

예를 들어, 쌀과 같은 일부 수중식물은 에틸렌이 성장을 촉진시키는 반면, 나도좀개구리밥 (*Lemna minor*)과 같은 다른 식물에서는 성장을 방해한다.

]

]

[0066]

[In a previous study, ethephon treatment was found to increase the total number of corms in potted freesias without changing the overall weight.

[이전 연구에서 에테폰 처리가 화분에 담긴 프리지아의 전체 중량 변화없이 알줄기의 전체 수를 증가시키는 것으로 확인되었다.

Additionally, ethephon treatment reduced leaf size in several plants, including oat (*Avena sativa*), cornflower, and poa pratensis.

또한, 에테폰 처리는 귀리 (*Avena sativa*), 거이삭속 및 왕포아풀 (*Poa pratensis*)을 포함하여 몇몇 식물의 잎 크기를 감소시켰다.

]

]

[0067]

[Similarly, it was confirmed that ethephon treatment in the cultivation of the frog's eye grass increased the number of leaves and decreased the total dry weight.

[이와 유사하게 좀개구리밥 배양에 있어 에테폰 처리는 잎의 수를 증가시키고 전체 건조중량을 감소시키는 것이 확인되었다.

]

]

[0069]

[B[attributes={}; value=[<Example 2> Confirmation of changes in metabolic profile due to ethephon in the cultivation of the frog plant]]]

[B[attributes={}; value=[<실시예 2> 좀개구리밥 배양에 있어서 에테폰에 의한 물질대사 프로파일의 변화 확인]]]

[0070]

[GC-MS analysis was performed to identify 48 metabolites in the frog's tail grass, as shown in Table 2.

[GC-MS 분석을 수행하여 표 2와 같이 좀개구리밥에서 48개의 대사물질을 확인하였다.

]

]

[0071]

[Referring to Figure 3 and Table 3, significant differences in relative intensities were confirmed among the metabolites of each treatment group.

[도 3 및 표 3을 참고하면, 각각 다른 처리군의 대사물질 중에서 상대적 강도에 유의적 차이가 확인되었다.

Ethephon treatment increased the relative levels of most alcohols in almost all treatment groups.

에테폰 처리는 거의 모든 처리군에서 대부분의 알코올의 상대적인 수준을 증가시켰다.

However, the relative levels of amino acids were significantly increased under the treatment with 0.05, 0.2 and 0.5 mM ethephon, significantly decreased under 1 mM ethephon and no change was observed under 1 mM ethephon.

그러나, 0.05, 0.2 및 0.5 mM 에테폰이 처리하에서는 아미노산의 상대적 수준이 유의적으로 증가한 반면, 1 mM 에테폰 하에서는 유의적으로 감소되었으며, 1 mM 에테폰 하에서 어떠한 변화도 나타나지 않았다.

]

]

[0072]

[Most fatty acids significantly increased in the ethephon treatment group.

[에테폰 처리군에서 대부분의 지방산이 유의적으로 증가하였다.

Organic acids were significantly increased under 0.05 and 0.2 mM ethephon treatments, but showed a tendency to significantly decrease after 0.1, 0.5, and 1 mM ethephon treatments.

유기산은 0.05 및 0.2 mM 에테폰 처리하에서 현저하게 증가하였으나 0.1, 0.5 및 1 mM 에테폰 처리 후 유의적으로 감소하는 경향이 확인되었다.

In general, ethephon increased the content of phenol compounds and decreased the sugar content.

종합적으로 에테폰은 페놀 화합물 함량은 증가시켰으며, 당 함량은 감소시켰다.

Interestingly, GABA content was significantly increased at all concentrations of ethephon.

흥미롭게도 에테폰의 모든 농도에서 GABA 함량은 현저하게 증가된 것을 확인할 수 있었다.

]

]

[0073]

[Meanwhile, as shown in the green box in Fig. 3, the relative levels of myo-inositol and myo-inositol phosphate increased in most ethephon-treated groups, while the relative levels of galactose decreased.

[한편, 도 3의 녹색 박스와 같이 대부분의 에테폰 처리군에서 미오이노시톨 (myo-inositol) 및 미오이노시톨 인산염의 상대적인 수준이 증가하는 동안 갈락토스의 상대적 수준은 감소하였다.

]

]

[0074]

[From the above results, it can be suggested that galactose is used in the synthesis of myoinositol and myoinositol phosphate under ethephon treatment, resulting in a decrease in its content.

[상기 결과로부터 갈락토스는 에테폰 처리하에서 미오이노시톨 및 미오이노시톨 인산염 합성에 사용되어 함량이 감소하는 것으로 제안될 수 있다.

]

]

[0075]

[Myo-inositol is known to play an important role in the growth and development of ornamental trees and water hyacinths in particular.

[미오이노시톨은 특히, 관상수 및 나도좁개구리밥의 성장 및 발달에 중요한 역할을 하는 것으로 알려져있다.

Additionally, inositol phosphates play a role in cell signaling in *Arabidopsis thaliana*.

또한, 이노시톨 인산염은 애기장대 (*Arabidopsis thaliana*)에서 세포 신호전달 역할을 한다.

According to previous reports, ethylene treatment of the cytoplasm of rubber tree cells increased myoinositol phosphate synthesis and converted glucose-6-phosphate to myoinositol phosphate.

앞선 보고에 따르면, 고무나무 세포의 세포질에 에틸렌 처리는 미노이노시톨 인산염 합성을 증가시켰으며, 글루코스-6-인산을 미오이노시톨 인산염으로 전환시켰다.

]

]

[0076]

[Accordingly, it can be suggested that myo-inositol phosphate synthase may be induced by ethephon treatment, resulting in an increase in the relative levels of myo-inositol and myo-inositol phosphate.

[이에 따라, 미오이노시톨 인산염 합성효소는 에테폰 처리에 의해 유도될 수 있으며, 결과적으로 미오이노시톨 및 미오이노시톨 인산염의 상대적 수준을 증가시키는 것으로 제안될 수 있다.

]

]

[0077]

[Proline and GABA levels were increased in all ethephon-treated groups without changes in glutamine levels, except in the 1 mM ethephon-treated group.

[프롤린 및 GABA 수준은 1 mM 에테폰 처리군을 제외하고 모든 에테폰 처리군에서 글루타민 수준 변화 없이 증가되었다.

Additionally, as shown in the blue box in Fig. 3, it was confirmed that the glutamic acid level increased under 0.05 mM and 0.2 mM ethephon treatment, and decreased at a concentration of 1 mM.

또한, 도 3의 파랑 박스와 같이 글루타민산 수준은 0.05 mM 및 0.2 mM 에테폰 처리하에서 증가하였으며, 1 mM 농도에서는 감소하는 것을 확인할 수 있었다.

]

]

[0078]

[Glutamic acid is used to produce proline and GABA, but glutamine is unlikely to be used.

[글루타민산은 프롤린 및 GABA를 생성하는데 사용되지만 글루타민은 그렇지 않을 가능성이 있다.

]

]

[0079]

[Proline and GABA are known to be modulators of stress resistance.

[프롤린 및 GABA는 스트레스 저항성 조절자로 알려져있다.

Previous studies have shown that ethephon treatment in olive leaves increased the production of reactive oxygen species (ROS), which cause oxidative stress.

이전 연구에 따르면 올리브 잎에서 에테폰 처리는 산화스트레스를 야기시키는 활성산소종(ROS) 생산을 증가시켰다.

In particular, GABA is synthesized from glutamate via glutamate decarboxylase, and this enzyme is known to be regulated through Ca^{2+} /calmodulin (CaM) accumulation.

특히, GABA는 글루타민산 탈탄산효소를 통해 글루타민산으로부터 합성되며, 상기 효소는 Ca^{2+} /calmodulin (CaM) 축적을 통해 조절되는 것으로 알려졌다.

]

]

[0080]

Previous studies have shown that environmental stress increases cytosolic Ca^{2+} levels.

[이전 연구에서 환경 스트레스는 세포질내 Ca^{2+} 수준을 증가시키는 것으로 확인되었다.

Most plant glutamate decarboxylases have a calmodulin binding domain, which binds calmodulin in the presence of Ca^{2+} .

대부분의 식물의 글루타민산 탈탄산효소는 칼모듈린 (calmodulin) 결합 도메인을 가지며, 상기 도메인은 Ca^{2+} 존재하에서 칼모듈린과 결합한다.

]

]

[0081]

[Accordingly, the increased level of GABA may be due to oxidative stress induced by ethephon treatment and may be suggested to be derived from increased activity of glutamate decarboxylase.

[이에 따라, GABA의 증가 수준은 에테폰 처리에 의해 유도된 산화스트레스에 의한 것일 수 있으며, 글루타민산 탈탄산효소의 활성 증가에 유래한 것으로 제안될 수 있다.

]

]

[0082]

[The relative levels of serine, glycine, and threonine increased in the ethephon-treated group.

[세린, 글리신 및 트레오닌의 상대적 수준은 에테폰 처리군에서 증가하였다.

Similarly, the levels of caffeic acid and ferulic acid also increased in most ethephon-treated groups except the 1 mM ethephon-treated group.

유사하게 카페인산 및 페룰산의 수준 또한 1 mM 에테폰 처리군을 제외한 대부분의 에테폰 처리군에서 증가하였다.

However, tryptophan and p-coumaric acid levels decreased in most treatment groups, while no change in tryptamine levels was observed.

그러나, 트립토판 (tryptophan) 및 p-쿠마린산 (p-coumaric acid)은 대부분의 처리군에서 감소한 반면 트립타민 (tryptamine)의 수준 변화는 나타나지 않았다.

Serine is a precursor for glycine and tryptophan biosynthesis.

세린은 글리신과 트립토판 생합성 전구체이다.

]

]

[0083]

[Because tryptophan is used in the biosynthesis of p-coumaric acid, p-coumaric acid can be converted into caffeic acid and phenulic acid, as shown in the red box in Figure 3.

[트립토판은 p-쿠마린산의 생합성에 사용되므로, 도 3의 적색 박스와 같이 p-쿠마린산은 카페인산 및 페놀산으로 전환될 수 있다.

]

]

[0084]

[According to a previous report, the concentration of caffeic acid in ethylene-treated lettuce was found to be ninefold higher relative to the control group, suggesting that ethephon may play a role in converting serine to tryptophan via p-coumaric acid, and then converting tryptophan to caffeic acid and phenulic acid.

[앞선 보고에 따르면, 에틸렌 처리된 상추에서 대조군과 비교하여 상대적으로 카페인산의 농도가 9배 증가한 것으로 확인됨에 따라, 에테폰이 p-쿠마린산을 통해 세린을 트립토판으로 전환시킨 후 트립토판을 카페인산 및 페놀산으로 전환시키는 역할을 하는 것으로 제안될 수 있다.

]

]

[0085]

[The metabolic profiles obtained by GC-MS were plotted as score plots derived from PCA, and the score plots derived from PCA of the frog's eye and quality control (QC) samples, as shown in Fig. 4, were used to confirm the correlation between the treatment groups.

[GC-MS로 얻은 대사 프로필을 PCA에 의해 유도된 점수 플롯으로 플롯팅하였으며, 도 4와 같이 쯤개구리밥 과 정도관리 (QC) 샘플의 PCA에 의해 유도된 점수 플롯은 처리 그룹간의 상관관계를 확인하기 위해 사용되었 다.

]

]

[0086]

[High aggregation of all QC samples in GC-MS was detected in the score plot derived by PCA, confirming the high stability of the GC-MS analysis platform throughout the entire experimental period.

[GC-MS에서 모든 QC 샘플의 고응집은 PCA에 의해 유도된 점수 플롯에서 검출되었으며, 이를 통하여 전체 실험기간 동안 GC-MS 분석 플랫폼의 높은 안정성이 확인되었다.

While the treatment groups were clearly separated, the samples were closely clustered together, and the separation between the control and treatment groups increased as the ethephon concentration increased.

처리군은 명확하게 분리된 반면, 샘플은 서로 밀접하게 모여있었으며, 에테폰 농도가 증가할수록 대조군과 처리군간의 분리가 증가하였다.

]

]

[0087]

[From the above results, it was confirmed that ethephon treatment significantly affected the metabolic profile of the frog's head.

[상기 결과로부터 에테폰 처리는 좁개구리밥의 대사 프로파일을 매우 영향을 나타내는 것이 확인되었다.

]

]

[0088]

[Additionally, caffeic acid, GABA, and ferulic acid were identified based on the metabolic profile changed by ethephon treatment.

[또한, 에테폰 처리에 의해 변화된 대사 프로파일을 기반으로 카페인산 (caffeic acid), GABA 및 페룰산 (ferulic acid)을 확인하였다.

The above components exhibited increased relative strength levels in unit cells and are known to be useful in human health and disease management.

상기 성분들은 단위 세포에서 증가된 상대적 강도 수준을 나타내었으며, 인간 건강 및 질병 관리에 유용한 것으로 알려져있다.

To obtain an estimate of the production of the above compounds in the culture of the frog-shaped rice, the compounds were quantified.

좀개구리밥 배양에서 상기 화합물의 생산 추정치를 얻기 위해 화합물을 정량화 하였다.

]

]

[0089]

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[0093]

[B[attributes={}; value=[<Example 3> Confirmation of the production of GABA and ferulic acid in the cultivation of duckweed according to various ethephon treatment concentrations]]]

[B[attributes={}; value=[<실시에 3> 다양한 에테폰 처리농도에 따른 좁개구리밥 배양에서 가바 및 페룰산
의 생산량 확인]]]

[0094]

[Referring to Figure 4 and Table 4, the relative level of caffeic acid in the unit cell increased, but a significant decrease in caffeic acid was confirmed by ethephon treatment, and thus the production levels of GABA and ferulic acid were confirmed.

[도 4 및 표 4를 참고하면 단위세포에서 카페인산의 상대적 수준이 증가하였으나, 에테폰 처리에 의해 카페인산의 유의한 감소가 확인됨에 따라, GABA 및 페룰산의 생산 수준을 확인하였다.

]

]

[0095]

[In animals, GABA is known as a neurotransmitter in the central nervous system, and in plants, it acts on cell signaling and accumulates in response to environmental stress.

[동물에 있어서, 가바는 중추신경 시스템의 신경전달물질로 알려져있으며, 식물에서는 세포 신호전달에 작용하고, 환경 스트레스에 반응하여 축적된다.

It is also used as a relaxant and hormone regulator in the treatment of insomnia, narcolepsy, and epilepsy.

또한, 불면증, 기면증 및 뇌전증 치료에 있어서, 이완 및 호르몬 조절자로 사용된다.

]

]

[0096]

[Furthermore, ferulic acid is a natural phenol that plays an important role in antioxidant activity.

[또한, 페룰산은 천연 페놀로 항산화에 중요한 역할을 한다.

According to previous reports, phenolic acid extracted from *Tetragonia tetragonioides* exhibited whitening and wrinkle improvement effects, and when ferulic acid was combined with ascorbic acid and α -tocopherol in the epidermis, it was confirmed to induce thymine dimer formation and inhibition of ROS.

앞선 보고에 따르면, 번행초 (*Tetragonia tetragonioides*)에서 추출된 페룰산은 미백 및 주름 개선 효과를 나타내었으며, 표피에서 페룰산을 아스코르브산 및 α -토코페롤과 병용처리할 경우, 티민이량체 형성 및 ROS의 저해를 유도하는 것으로 확인되었다.

]

]

[0097]

[Referring to Table 4, the production levels of GABA and ferulic acid were 1.599 to 5.041 mg/L and 0.129 to 0.640 mg/L, respectively.

[표 4를 참고하면 GABA 및 페룰산의 생산량은 각각 1.599에서 5.041 mg/L 및 0.129에서 0.640 mg/L 수준이었다.

However, high GABA production was confirmed at 5.041 ± 1.373 mg/L in the 0.5 mM ethephon treatment group, 3.394 ± 0.895 mg/L in the 0.2 mM ethephon treatment group, and 3.101 ± 0.808 mg/L in the 0.05 mM ethephon treatment group.

그러나 0.5 mM 에테폰 처리군에서 5.041 ± 1.373 mg/L, 0.2 mM 에테폰 처리군에서 3.394 ± 0.895 mg/L 및 0.05 mM 에테폰 처리군에서 3.101 ± 0.808 mg/L의 높은 GABA 생산이 확인되었다.

]

]

[0098]

[From the above results, it was confirmed that 0.5 mM ethephon was the optimal concentration for increasing GABA production, whereas 1 mM ethephon did not increase GABA production.

[상기 결과로부터 0.5 mM 에테폰은 GABA 생산 증가를 위한 최적의 농도인 것이 확인된 반면, 1 mM 에테폰은 GABA 생산을 증가시키지 못한 것이 확인되었다.

]

]

[0099]

[In addition, the highest production of ferulic acid (0.640 ± 0.071 mg/L) was confirmed in the 0.2 mM ethephon treatment group. Except for the 1 mM treatment group, the production of ferulic acid significantly increased in all treatment groups.

[또한, 페룰산은 0.2 mM 에테폰 처리군에서 가장 높은 생산량 (0.640 ± 0.071 mg/L)이 확인되었다. 1 mM 처리군을 제외하고, 페룰산은 모든 처리군에서 생산량이 유의하게 증가하였다.

]

]

[0100]

[From the above results, it was confirmed that the culture of the frog's tail grass treated with 0.2 mM ethephon improved ferulic acid production, and thus could be usefully used in the cosmetics and pharmaceutical industries.

[상기 결과로부터 0.2 mM 에테폰이 처리된 좀개구리밥 배양은 페룰산 생산을 향상시키므로, 화장품 및 의약품 산업에 유용하게 사용될 수 있음이 확인되었다.

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[0103]

[As specific parts of the present invention have been described in detail above, it will be apparent to those skilled in the art that such specific descriptions are merely preferred embodiments and that the scope of the present invention is not limited thereby.

[이상으로 본 발명 내용의 특정한 부분을 상세히 기술하였는 바, 당업계의 통상의 지식을 가진 자에게 있어서, 이러한 구체적 기술은 단지 바람직한 실시양태일 뿐이며, 이에 의해 본 발명의 범위가 제한되는 것이 아닌 점은 명백할 것이다.

Accordingly, the substantial scope of the present invention is defined by the appended claims and their equivalents.

따라서 본 발명의 실질적인 범위는 첨부된 청구항들과 그것들의 등가물에 의하여 정의된다고 할 것이다.

]

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