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## 피마자유와 양명아주 추출물을 원료로 하는 유기농업자재 유효성분의 열 안정성 평가

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### Thermal Stability of Representative Bioactive Compounds in Biopesticide Derived from Castor Oil or Wormseed Extract under Controlled Temperature

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#### Abstract

**BACKGROUND:** Castor oil and wormseed extract are important active ingredients for biopesticide, and ricinoleic acid in castor oil and three monoterpenes (ascaridole, carvacrol and *p*-cymene) in wormseed extract are known bioactive substances. However, their stabilities had not been studied, even though the stability was the core property for estimation of shelf-life of biopesticide. Aimed to investigate the thermal stabilities of the bioactive substances in castor oil and wormseed extracts.

**METHODS AND RESULTS:** The contents of ricinoleic acid and three monoterpenes (ascaridole, carvacrol and *p*-cymene) were analyzed by gas chromatography (GC). The thermal stabilities of the bioactive substance were measured at 0°C, 23°C, 30°C, 40°C, 45°C and 54°C for 84 d. The half-lives of ricinoleic acid in biopesticides was ranged from 28.9 d to 57.8 d at 30°C, and the stability of

pure castor oil were located in the range ( $t_{1/2}$ =46.2 d for Indian product and 27.7 d for Korean product) at the same temperature. The half-lives of the total monoterpenes in biopesticides were ranged from 3.9 d to 27.7 d at 30°C. Among the monoterpenes, the stability ascaridole and *p*-cymene were decreased in acidic condition. All the bioactive substances showed similar stability on the different thermal conditions.

**CONCLUSION:** The half-lives of most bioactive substance from castor oil and wormseed extracts were less than 100 d. To increase the stability of bioactive substance in biopesticide, stabilizing additives like antioxidant and oxygen remover should be considered to extend of the shelf-life.

**Key words:** Ascaridole, Biopesticide, Carvacrol, *p*-Cymene, Ricinoleic acid, Thermal stability

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 ricinoleic acid (Kim *et al.*, 2008).  
 monoterpene ascaridole,  
 carvacrol, *p*-cymene limonene  
 (Cavalli *et*  
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*p*-cymene  
 (Kim *et al.*, 2016).  
 5 ricinoleic  
 acid, ascaridole, carvacrol, *p*-cymene  
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**재료 및 방법**

**표준품 및 시약**

Ascaridole (99%) City Chemical LLC. (West Haven, USA), *p*-cymene (98%) Wako Co. (Tokyo, Japan)  
 . Ricinoleic acid (99%), boron trifluoride (BF<sub>3</sub>, 14% in methanol), ENVI- Carb™ SPE cartridge (250 mg, 3 mL 500 mg, 6 mL) carvacrol

(98%) Sigma-Aldrich Co. (St. Louis, MO, USA)  
 . HPLC acetone, acetonitrile, methanol, isooctane sodium hydroxide Merck & Co., Inc. (Darmstadt, Germany) , C<sub>18</sub> SPE (500 mg, 6 mL) Phenomenex Inc. (CA, USA) , hydrophilic lipophilic SPE cartridge (HLB, 60 mg, 3 mL) Waters Co. (MA, USA)

**Ricinoleic acid 분석**

ricinoleic acid Choi *et al.*  
 (2016b) methylation  
 GC  
 (20 mg) isooctane 1 mL, 0.5 N methanolic sodium hydroxide 가 가 100°C 5 가 . , 1 mL isooctane, BF<sub>3</sub> (14%) 30 (5 mL) 가  
 30  
 , dichloromethane gas chromatography (GC)-time to flight mass spectrometry (TOFMS)

**Monoterpene 분석**

Ascaridole carvacrol, *p*-cymene Yang *et al.* (2016)  
 10 100  
 . HLB-SPE cartridge (60 mg, 3 mL)  
 2 mL acetone 1 mL 1  
 mL loading , 10 가  
 SPE 2 mL acetone (2 mL×2)  
 5 mL  
 GC-FID

**기기조건**

Ricinoleic acid ascaridole, carvacrol, *p*-cymene  
 GC Yang *et al.* (2016)  
 , Table 1

**열 안정성 평가**

5  
 chamber  
 0°C, 23°C, 30°C, 40°C, 45°C 54°C

**Table 1. Instrumental condition of GC for analysis of ricinoleic acid, ascaridole, carvacrol and *p*-cymene**

Compound	Methyl ricinoleic acid				Compound	Ascaridole, carvacrol, <i>p</i> -cymene			
Instrument	Agilent 7890A with time-of-flight mass spectrometry				Instrument	Agilent 6890 series with flame ionization detector			
Column	SP-2330 (30 m×0.25 mm, 0.2 μm)				Column	DB-5 (30 m×0.25 mm, 0.25 μm)			
Column flow	Helium 1.0 mL/min				Column flow	Helium 3.0 mL/min			
	Temp. (°C)	Rate (°C/min)	Hold (min)	Total (min)		Temp. (°C)	Rate (°C/min)	Hold (min)	Total (min)
Oven	100		3	3	Oven	50		2	2
	240	20		15	Oven	100	10		7
	Injector temperature: 240°C					140	4		17
	Ionization mode		Electronic impact mode at 70 eV			250	20		22.5
MS	Ion source temperature		230°C		Detector	250°C			
	Transfer line temperature		200°C		Injector	Injector volume: 1 (splitless mode)			
	Scan range		50-500 <i>m/z</i>			Injector temperature: 220°C			

**Table 2. Ingredient list of the biopesticides**

Biopesticide A	Sesame oil, castor oil
Biopesticide B	Castor oil
Biopesticide C	Plant extract (Chinese scholar tree, Japanese bead tree, Wormseed)
Biopesticide D	Plant extract (Chinese scholar tree, Japanese bead tree, Wormseed), wood vinegar
Biopesticide E	Plant extract (Chinese scholar tree, Japanese bead tree, Wormseed), paraffin oil

**Table 3. Total contents of the selected bioactive compounds in the biopesticides and commercial product**

	Bioactive compound contents (%)				
	Ricinine	Ricinoleic acid	Ascaridole	Carvacrol	<i>p</i> -Cymene
Castor oil (India)	ND*	58.5	ND	ND	ND
Castor oil (Korea)	ND	71.7	ND	ND	ND
Biopesticide A	< 0.01	20.9	ND	ND	ND
Biopesticide B	< 0.01	34.9	ND	ND	ND
Biopesticide C	ND	ND	0.08	0.16	ND
Biopesticide D	ND	ND	0.49	0.03	0.20
Biopesticide E	ND	ND	0.03	0.01	ND

\*ND means no detection

**결과 및 고찰****유효물질 함량 조사**

Castor oil (India) and Castor oil (Korea) contained 58.5% and 71.7% ricinoleic acid, respectively. Biopesticide A and B contained 20.9% and 34.9% ricinoleic acid, respectively. Biopesticide C contained 0.08% ascaridole and 0.16% carvacrol. Biopesticide D contained 0.49% ascaridole, 0.03% carvacrol, and 0.20% *p*-cymene. Biopesticide E contained 0.03% ascaridole, 0.01% carvacrol, and 0.04% *p*-cymene. Ricinine was not detected in any of the samples.



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