New Sesamol Ethers as Pyrethrum Synergists[†]

C. DEVAKUMAR, V. S. SAXENA* and S. K. MUKERJEE

Division of Agricultural Chemicals,
 Indian Agricultural Research Institute,
 New Delhi-110012, India

Received July 27, 1984

Several new methylenedioxyphenyl (MDP) ethers were synthesised from sesamol and methoxy substituted sesamols and screened as pyrethrum synergists. In general, the synergistic activity increased with the methoxyl substituents and decreased in the corresponding alkenyl analogs. The synergistic activity of alkyl ethers was found to vary with the alkyl chain, *n*-propyl ethers showing the maximum. In the case of alkenyl ethers, the activity followed the order γ,γ -dimethyl allyl > β -methallyl > allyl and showed no correlation between R_m and synergistic activity.

The commercial importance of methylenedioxyphenyl (MDP) compounds like piperonylbutoxide (PBO) and dihydrodillapiol¹⁾ as pyrethrum synergists is well known. Earlier work from this laboratory indicated that methoxyl substitution in the nucleus increases the synergistic activity of the parent MDP compound.²⁾

In order to see the effect of other types of

ethers, we have now prepared several sesamol ethers of varying chain length alone or in combination with methoxyl groups and tested them as pyrethrum synergists.

MATERIALS AND METHODS

¹H NMR spectra were recorded on a Varian A-90 spectrometer using TMS as the internal reference; chemi-

SCHEME 1. Synthesis of Test Ethers.

[†] Contribution No. 247 from Division of Agricultural Chemicals, IARI, New Delhi-110012.

* Present address: Division of Entomology, IARI, New Delhi-12, India.

cal shifts are given in δ values. The melting and boiling points reported in Tables I~III are uncorrected. Piperonal and alkyl halides procured from commercial suppliers were distilled before use.

1) *Synthesis of compounds*. The synthetic routes of the test ethers are shown in Scheme 1.

Sesamol (1). This was prepared by Baeyer-Villiger oxidation of piperonal. Performic acid was prepared *in situ* by mixing 30% H_2O_2 (75 ml) with 85% formic acid (250 ml) at 0°C and allowing it to warm to room temperature for one hour. An ice cold solution of the acid was added to a solution of piperonal (75 mg, 0.5 mol) in 85% formic acid (750 ml) maintained at 5°C and the whole mixture was refrigerated for 16 hr. Thereafter, the procedure of Dallacker³⁾ was followed to obtain **1** in a 35% yield, mp 65°C (reported 65.5°C).

Sesamyl methyl ether (I). Methylation of **1** following the general procedure of etherification (described below) in refluxing acetone with dimethyl sulphate and anhyd. K_2CO_3 yielded **I** quantitatively as a colourless oil after vacuum distillation. *Anal.* Found: C, 62.9; H, 5.26. Calcd. for $\text{C}_9\text{H}_{10}\text{O}_3$: C, 63.15; H, 5.30%. PMR (CCl_4): 3.70 (s, 3H, OCH_3), 5.85 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

2-methoxypiperonal (2). This was obtained by Vilsmeier formylation of **1** in a quantitative yield. *N*-Methyl formanilide (11.2 gm) and phosphorus oxychloride (11.5 gm) were mixed dropwise in chlorobenzene at 0°C . After one hour, this mixture was added to a solution of **1** (7.6 gm) in chlorobenzene (15 ml) at 0°C , was stirred for 24 hr at room temperature and cooled to approximately 10°C when the product crystallised out. This was filtered, washed with water and recrystallised from hexane-benzene (1:1), mp 111°C (lit.³⁾ 111°C).

Dillapialdehyde (5). This was obtained from isodillapiole (4) by an improvement of the earlier procedure.⁴⁾ KMnO_4 (0.2 mol) was added in small lots to a well-stirred solution of isodillapiole (0.1 mol) in acetone (250 ml) containing water (40 ml) maintained at 0°C for 20 mins. CO_2 gas was simultaneously bubbled through the suspension in order to expel the released oxygen as well as to reduce the alkalinity of the medium. After the usual working up, the crude product (20 gms) was eluted through a short column of silica gel (75 gms) with hexane and the aldehyde (5) was recrystallised from hexane-benzene (1:1). Yield 78%, mp 75°C (reported,⁴⁾ 75°C).

2-methoxysesamol (3) and 2, 3, *dimethoxysesamol* (6). These were prepared in a manner similar to that for sesamol (1) following the procedure reported by Dallacker^{3,5)} by the Baeyer-Villiger oxidation of piperonals **2** and **5**, respectively. Yields of **3** and **6** were 80 and 40% respectively. Both were recrystallised from cyclohexane, mp of **3**, 84°C (lit.³⁾ 84°C) and of **6**, $82\sim 83^\circ\text{C}$ (lit.⁵⁾ 83°C).

General Procedure for the preparation of ethers II to

XVII, XX and XXI. The respective sesamol **1**, **3** or **6** (10 mmol) and the corresponding alkyl bromide (11 mmol) in acetone (70 ml) containing anhyd. K_2CO_3 (20 mmol) were refluxed over a waterbath for 4~6 hr. An aliquot was cooled, K_2CO_3 was filtered off, acetone was evaporated and the residue was taken up in diethylether (50 ml), extracted once with 2N NaOH (20 ml) and washed with water (3×20 ml) till neutral. The crude product was purified by vacuum distillation to furnish the test ethers in pure forms. The ethers XIII, XIV, XX and XXI were purified by silica gel column chromatography instead of distillation.

Sesamylethyl ether (II). *Anal.* Found: C, 64.82; H, 6.01. Calcd. for $\text{C}_9\text{H}_{10}\text{O}_3$: C, 65.05; H, 6.07%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 3.7~3.9 (q, $J=7$ Hz, 2H, OCH_2CH_3), 5.87 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

Sesamyl n-propylether (III). *Anal.* Found: C, 66.4, H, 6.70. Calcd. for $\text{C}_{10}\text{H}_{12}\text{O}_3$: C, 66.65; H, 6.71%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.6~1.9 (m, 2H, $-\text{CH}_2-\text{CH}_3$), 3.7~3.9 (t, $J=7$ Hz, 2H, OCH_2CH_2), 5.85 (s, 2H, $-\text{OCH}_2\text{O}$), 6.3~6.7 (m, 3H, aromatic).

Sesamyl n-butylether (IV). *Anal.* Found: C, 67.93; H, 7.20. Calcd. for $\text{C}_{11}\text{H}_{14}\text{O}_3$: C=68.02; H, 7.27%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.2~1.5 (m, 2H, CH_2CH_3), 1.6~1.9 (m, $J=7$ Hz, 2H, $\text{CH}_2-\text{CH}_2-\text{C}_2\text{H}_5$), 3.7~3.9 (t, $J=7$ Hz, 2H, OCH_2C), 5.86 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

Sesamyl n-pentylether (V). *Anal.* Found: C, 69.0; H, 7.70. Calcd. for $\text{C}_{12}\text{H}_{16}\text{O}_3$: C, 69.21; H, 7.72%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.2~2.0 (m, 6H, methylenic), 3.7~3.9 (t, $J=7$ Hz, 2H, OCH_2CH_2), 5.85 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

Sesamyl n-hexylether (VI). *Anal.* Found: C, 70.1; H, 8.10. Calcd. for $\text{C}_{13}\text{H}_{18}\text{O}_3$: C, 70.24; H, 8.16%. PMR (CCl_4): 0.85~1.0 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.2~2.0 (m, 8H, methylenic), 3.7~3.85 (t, $J=7$ Hz, 2H, OCH_2CH_2), 5.87 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

2-Methoxysesamyl methylether (VII). This was recrystallised from petroleum ether, mp $110\sim 111^\circ$ (lit.³⁾ 111°C). *Anal.* Found: C, 59.3; H, 5.50. Calcd. for $\text{C}_9\text{H}_{10}\text{O}_4$: C, 59.34; H, 5.53%.

2-Methoxysesamyl n-propylether (VIII). *Anal.* Found: C, 67.25; H, 7.17. Calcd. for $\text{C}_{11}\text{H}_{14}\text{O}_4$: C, 67.34; H, 7.19%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.6~1.9 (m, 2H, $\text{CH}_2\text{CH}_2\text{CH}_3$), 3.66 (s, 3H, OCH_3), 3.7~3.9 (t, $J=7$ Hz, 2H, OCH_2CH_2), 5.85 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic), 6.5 (s, 1H, aromatic).

2,3-Dimethoxysesamyl methylether (IX). This was recrystallised as colourless crystals from petroleum ether, mp $45\sim 46^\circ\text{C}$ (lit. 46°C). *Anal.* Found: C, 56.7; H, 5.65. Calcd. for $\text{C}_{10}\text{H}_{12}\text{O}_5$: C, 56.6; H, 5.70%.

2,3-Dimethoxysesamyl ethylether (X). *Anal.* Found: C, 58.2; H, 6.18. Calcd. for $\text{C}_{11}\text{H}_{14}\text{O}_5$: C, 58.4; H, 6.24%. PMR (CCl_4): 0.9~1.2 (t, $J=7$ Hz, 3H, CH_2CH_3), 3.65 (s, 3H, OCH_3), 3.92 (s, 3H, OCH_3), 3.7~3.85 (q, 2H, $J=7$ Hz, CH_2CH_3), 5.85 (s, 2H, OCH_2O), 6.3 (s, 1H,

aromatic).

2,3-Dimethoxysesamyl *n*-propylether (XI). *Anal.* Found: C, 59.85; H, 6.72. Calcd. for $C_{12}H_{16}O_5$: C, 59.99; H, 6.71%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.15~1.9 (m, 2H, $CH_2CH_2CH_3$), 3.65 (s, 2H, OCH_3), 3.92 (s, 3H, OCH_3), 3.7~3.85 (q, $J=7$ Hz, 2H, OCH_2), 5.82 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

2,3-Dimethoxysesamyl *n*-butylether (XII). *Anal.* Found: C, 61.1; H, 7.1. Calcd. for $C_{13}H_{18}O_5$: C, 61.4; H, 7.14%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.15~1.9 (m, 4H, $CH_2CH_2CH_3$), 3.66 (s, 3H, OCH_3), 3.7~3.84 (q, $J=7$ Hz, 2H, OCH_2CH_2), 3.92 (s, 3H, OCH_3), 5.82 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

2,3-Dimethoxysesamyl *n*-pentylether (XIII). *Anal.* Found: C, 62.5; H, 7.47. Calcd. for $C_{14}H_{20}O_5$: C, 62.67; H, 7.51%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.2~1.9 (m, 6H, $(CH_2)_3CH_3$), 3.67 (s, 3H, OCH_3), 3.7~3.85 (t, $J=7$ Hz, 2H, OCH_2), 3.92 (s, 3H, OCH_3), 5.85 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

2,3-Dimethoxysesamyl *n*-hexylether (XIV). *Anal.* Found: C, 63.5; H, 7.80. Calcd. for $C_{15}H_{22}O_5$: C, 63.81; H, 7.85%. PMR (CCl_4): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.2~1.9 (m, 8H, $(CH_2)_4CH_3$), 3.7 (s, 3H, OCH_3), 3.7~3.85 (t, $J=7$ Hz, 2H, OCH_2CH_2), 3.92 (s, 3H, OCH_3), 5.85 (s, 2H, OCH_2O), 6.1 (s, 1H, aromatic).

Sesamylallylether (XV). *Anal.* Found: C, 67.3; H, 5.64. Calcd. for $C_{10}H_{10}O_3$: C, 67.4; H, 5.66%. PMR (CCl_4): 4.4 (d, $J=8$ Hz, 2H, OCH_2), 5.15~5.45 (m, 3H, vinylic), 5.85 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

2-Methoxysesamylallylether (XVI). *Anal.* Found: C, 63.25; H, 5.78. Calcd. for $C_{11}H_{12}O_4$: C, 63.45; H, 5.81%. PMR (CCl_4): 3.70 (s, 3H, OCH_3), 4.4 (d, $J=8$ Hz, 2H, OCH_2), 5.15~5.45 (m, 3H, vinylic), 5.85 (s, 1H, aromatic), 6.3 (s, 1H, aromatic), 6.45 (s, 1H, aromatic).

2,3-Dimethoxysesamylallylether (XVII). *Anal.* Found: C, 60.32; H, 5.84. Calcd. for $C_{12}H_{14}O_5$: C, 60.5; H, 5.92%. PMR ($CDCl_3$): 3.7 (s, 3H, OCH_3), 3.92 (s, 3H, OCH_3), 4.4 (d, 2H, $J=8$ Hz, OCH_2-C), 5.06~5.5 (m, 3H, vinylic), 5.85 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

Sesamyl γ,γ -dimethylallylether (XX). *Anal.* Found: C, 53.1; H, 5.15. Calcd. for $C_{12}H_{14}O_3$: C, 53.33; H, 5.22%. PMR ($CDCl_3$): 1.7, 1.8 (s, s, 3H, 3H, $-CH=C(CH_3)_2$), 4.55 (d, $J=6.5$ Hz, 2H, allylic), 5.48 (t, $J=6.5$ Hz, 1H, vinylic), 5.85 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, aromatic).

2,3-Dimethoxysesamyl γ,γ -dimethylallylether (XXI). *Anal.* Found: C, 62.90; H, 6.78. Calcd. for $C_{14}H_{18}O_5$: C, 63.14; H, 6.81%. PMR ($CDCl_3$): 1.7, 1.8 (s, s, 3H, 3H, $-CH=C(CH_3)_2$), 3.70, 3.92 (s, s, 3H, 3H, OCH_3 , OCH_3), 4.55 (d, $J=6.5$ Hz, OCH_2), 5.50 (t, $J=6.5$ Hz, 1H, vinylic), 5.92 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

General Procedure for the preparation of ethers XVIII, XIX and XXIV~XXVII. The sesamol (1 or 6, 5 mmol) was dissolved in absolute methanol (10 ml) containing sodium methoxide (5 mmol) and the corresponding alkyl chloride (5.5 mmol) was mixed with it under stirring. After 4~5 hr, the methanol was evaporated and the product was dis-

solved in diethylether (25 ml), washed with water and dried with anhyd. Na_2SO_4 . The residue, after evaporating the ether solvent was passed through a short column of silicagel (3 gm) with hexane-benzene (1:1) elution to furnish the test compounds in 85~90% yields. The alkyl chloride required for ethers XXVI and XXVII was obtained by conversion of butylcarbitol with Vilsmeier reagent.⁶⁾

Sesamyl β -methallylether (XVIII). *Anal.* Found: C, 68.65; H, 6.24. Calcd. for $C_{11}H_{12}O_3$: C, 68.73; H, 6.29%. PMR (CCl_4): 2.76 (s, 3H, $CH_3-C=CH_2$), 4.00 (s, 2H, OCH_3-C), 4.6 (s, 2H, vinylic), 5.85 (s, 2H, OCH_2O), 6.3~6.6 (m, 3H, aromatic).

2,3-Dimethoxysesamyl β -methallylether (XIX). *Anal.* Found: C, 61.73; H, 6.35. Calcd. for $C_{13}H_{16}O_5$: C, 61.89; H, 6.39%. PMR ($CDCl_3$): 2.76 (s, 3H, $CH_3-C=CH_2$), 3.72 (s, 3H, OCH_3), 3.9 (s, 3H, OCH_3), 4.0 (s, 2H, OCH_2-C), 4.6 (s, 2H, vinylic), 5.82 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

Sesamylbenzylether (XXIV). *Anal.* Found: C, 73.4; H, 5.25. Calcd. for $C_{14}H_{12}O_3$: C, 73.67; H, 5.28%. PMR (CCl_4): 5.4 (s, 2H, benzylic), 5.85 (s, 2H, OCH_2O), 6.3~6.7 (m, 3H, MDP aromatic), 6.8~7.3 (m, 5H, phenyl aromatic).

2,3-Dimethoxysesamyl benzylether (XXV). *Anal.* Found: C, 66.4; H, 5.52. Calcd. for $C_{16}H_{16}O_5$: C, 66.66; H, 5.59%. PMR ($CDCl_3$): 3.7, 3.9 (s, s, 3H, 3H, OCH_3 , OCH_3), 5.4 (s, 2H, benzylic), 6.3 (s, 1H, MDP aromatic), 6.8~7.3 (m, 5H, aromatic).

Sesamylbutoxide 5-[2-(2-butoxyethoxy)ethoxy]-1,3-benzodioxole (XXVI). *Anal.* Found: C, 61.80; H, 10.30. Calcd. for $C_{15}H_{22}O_5$: C, 63.75; H, 7.85%. PMR ($CDCl_3$): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.15~1.9 (m, 4H, $CH_2CH_2CH_3$), 3.3~3.7 (m, 8H, $(CH_2OCH_2)_2$), 3.7~3.85 (t, $J=7$ Hz, 2H, MDP- OCH_2), 5.85 (s, 2H, OCH_2O), 6.1~6.6 (m, 3H, aromatic).

2,3-Dimethoxysesamylbutoxide 6-[2-(2-(butoxyethoxy)ethoxy)-4,5-dimethoxy-1,3-benzodioxole (XXVII). *Anal.* Found: C, 58; H, 9.70. Calcd. for $C_{17}H_{26}O_7$: C, 59.60; H, 7.65%. PMR ($CDCl_3$): 0.9~1.1 (t, $J=7$ Hz, 3H, CH_2CH_3), 1.15~1.9 (m, 4H, $CH_2CH_2CH_3$), 3.3~3.7 (m, 8H, $(CH_2OCH_2)_2$), 3.7 (s, 3H, OCH_3), 3.72~3.85 (t, $J=7$ Hz, 2H, MDP- OCH_2), 5.85 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

β -Cyanoethylethers XXII and XXIII. These were prepared in 30% yields by Michael addition of the respective sesamols (1 or 6) with excess acrylonitrile under refluxing conditions for 20 hr, catalysing by a few drops of Triton B. The ethers were purified by recrystallisation from hexane-benzene (95:5) as colourless needles.

Sesamyl β -cyanoethylether (XXII). *Anal.* Found: C, 62.75; H, 4.74; N, 7.28. Calcd. for $C_{10}H_9O_2N$: C, 62.82; H, 4.75; N, 7.33%. PMR ($CDCl_3$): 2.76~2.9 (t, $J=6.4$ Hz, 2H, CH_2CN), 4.1~4.24 (t, $J=6.4$ Hz, 2H, OCH_2), 5.9 (s, 2H, OCH_2), 6.3~6.82 (m, 3H, aromatic).

2,3-Dimethoxysesamyl β -cyanoethylether (XXIII). *Anal.*

Found: C, 57.2; H, 5.2; N, 5.50. Calcd. for $C_{12}H_{13}O_5N$: C, 57.37; H, 5.22; N, 5.56%. PMR ($CDCl_3$): 2.76~2.9 (t, $J=6.4$ Hz, 2H, CH_2CN), 3.82 (s, 3H, OCH_3), 4.05 (s, 3H, OCH_3), 4.1~4.25 (t, $J=6.4$ Hz, 2H, OCH_2), 5.88 (s, 2H, OCH_2O), 6.3 (s, 1H, aromatic).

2) *The lipophilicity*. (R_m values) of the above test ethers was determined from R_f values on reverse phase TLC by the method of Boyce and Milborrow.⁷⁾

3) *Formulation and bioassay*. The synergistic activities of these ethers were assessed as pyrethrum-based emulsions at an insecticide to synergist ratio of 1:5 (w/w) using benzene (10%) and Tween 80 emulsifier (0.2%). Purified pyrethrum extract (20%) was used for making a stock solution (4%) in benzene for this purpose. Piperonyl butoxide (PBO) was used as the reference synergist. Red flour beetle (*Tribolium castaneum* Herbst) was the test insect as described previously.²⁾ Data were subjected to

probit analysis⁸⁾ and factors of synergism (S.F.), i.e., the ratio of LC_{50} for pyrethrum to LC_{50} for (pyrethrum + synergist), were computed from the LC_{50} values.⁹⁾

RESULTS AND DISCUSSION

The physicochemical and synergistic properties of all the ethers are given in Tables I~III. None of the test ethers showed any insecticidal activity up to the 1% level against the test insect, *Tribolium castaneum* Herbst. However, all of them exhibited some degree of synergism as shown in Tables I~III. It is seen from Figs. 1 and 2 that the lipophilicity (R_m values) of the alkyl ethers increased linearly with increasing alkyl chain while the factor of synergism in-

TABLE I. PHYSICOCHEMICAL AND SYNERGISTIC PROPERTIES OF MDP ALKYL ETHERS

S. No.	Alkyl ether (see Scheme 1)			bp/10 mmHg (°C)	R_m Value	Factor of synergism (S.F.)
	R_1	R_2	R_3			
I	H	H	CH_3	95~96	-0.09	1.40
II	H	H	C_2H_5	99~100	+0.11	1.59
III	H	H	$n-C_3H_7$	68~68.5	+0.37	1.71
IV	H	H	$n-C_4H_9$	71~72	+0.60	1.63
V	H	H	$n-C_5H_{11}$	75~76	+0.83	1.46
VI	H	H	$n-C_6H_{13}$	78~79	+1.06	1.28
VII	H	OCH_3	CH_3	110~111*	-0.21	1.52
VIII	H	OCH_3	$n-C_3H_7$	52~54*	+0.10	2.13
IX	OCH_3	OCH_3	CH_3	56~57*	-0.33	3.62
X	OCH_3	OCH_3	C_2H_5	112~113	-0.19	4.11
XI	OCH_3	OCH_3	$n-C_3H_7$	120~121	0.00	4.40
XII	OCH_3	OCH_3	$n-C_4H_9$	123~124	+0.14	4.18
XIII	OCH_3	OCH_3	$n-C_5H_{11}$	—	+0.31	3.80
XIV	OCH_3	OCH_3	$n-C_6H_{13}$	—	+0.47	3.47

* Melting point.

TABLE II. PHYSICOCHEMICAL AND SYNERGISTIC PROPERTIES OF MDP ALKENYL ETHERS

S. No.	Alkyl ether (see Scheme 1)			bp/10 mmHg (°C)	R_m Value	Factor of synergism (S.F.)
	R_1	R_2	R_3			
XV	H	H	Allyl	90	+0.14	1.04
XVI	H	OCH_3	-do-	—	+0.04	1.66
XVII	OCH_3	OCH_3	-do-	—	-0.07	2.23
XVIII	H	H		—	+0.31	1.31
XIX	OCH_3	OCH_3	-do-	—	+0.05	2.74
XX	H	H		—	+0.37	1.64
XXI	OCH_3	OCH_3	-do-	—	+0.10	3.05

TABLE III. PHYSICOCHEMICAL AND SYNERGISTIC PROPERTIES OF OTHER δ MDP ETHERS

S. No.	Ether (see Scheme 1)			mp (°C)	R_m Value	Factor of synergism (S.F.)
	R_1	R_2	R_3			
XXII	H	H	CN	78~79	-0.37	1.20
XXIII	OCH ₃	OCH ₃	-do-	62~63	-0.21	1.46
XXIV	H	H	Bz	—	+0.48	1.33
XXV	OCH ₃	OCH ₃	-do-	—	+0.33	1.54
XXVI	H	H	butoxide	—	+0.16	1.90
XXVII	OCH ₃	OCH ₃	-do-	—	-0.27	1.95
XXVIII	Piperonyl butoxide			—	—	2.10

FIG. 1. Effect of Alkyl Chain on R_m and S.F. of Sesamyl Ethers. FIG. 2. Effect of Alkyl Chain on R_m and S.F. of 2,3-Dimethoxy Sesamyl Ethers.

creased to C₃ and then steadily decreased in both the types of ethers. A comparison of the factors of synergism of the ethers having the same alkyl chain showed that the activity increased with the number of methoxyl groups. Thus, the propyl ether (XI) having two methoxyl groups was the most active compound of the series (S.F.=4.4) and the ether (III) having the same alkyl chain but no methoxyl group although active, had an S.F. of only 1.7. This confirms our earlier observation that synergistic activity is directly influenced by the number of methoxyl substi-

tuent in the nucleus and not by the lipophilicity alone. Otherwise, the general pattern of showing a maximum of activity as observed in earlier series is repeated here.²⁾

The R_m and factors of synergism of alkenyl ethers of sesamols are given in Table II. In general, these ethers were less active compared to their saturated analogues. In this series, both the factor of synergism and R_m decreased in the order allyl < β -methallyl < γ,γ -dimethylallyl fragments in both types of sesamols. Thus, the reduction in factor of synergism caused by the introduction of unsatura-

tion seems to be partly compensated by alkyl branchings. A similar deactivating influence was also observed with substituents like benzyl and nitrile in ethers XXII ~ XXIV as shown in Table III. It is also apparent from the synergistic factors of butoxides XXVI and XXVII that a long chain like a butoxide is not essential for a good synergist.

The overall yield of the ether XI from dillapiole is fairly good (*ca.* 40 ~ 45%) but the synthesis involves four steps. On the other hand, furapiole (2-methyl-5,6-methylenedioxy-7-methoxy-2,3-dihydrobenzofuran) with better synergistic activity (S.F. = 5.1) can be prepared in a good yield (70 ~ 80%) by a single step conversion of dillapiole.⁴⁾ Thus, the commercial potential for furapiole is better than

that of the ether XI.

REFERENCES

- 1) K. C. Gulati and B. S. Parmar, Indian Pat. No. 128,129 (1969).
- 2) S. S. Tomar, M. L. Maheshwari and S. K. Mukerjee, *J. Agric. Food Chem.*, **27**, 547 (1979).
- 3) F. Dallacker, *Liebigs Ann. Chem.*, **719**, 112 (1968).
- 4) S. S. Tomar, M. L. Maheshwari and S. K. Mukerjee, *Agric. Biol. Chem.*, **43**, 1479 (1979).
- 5) F. Dallacker, *Monat. Chem.*, **100**, 742 (1969).
- 6) D. R. Hepburn and H. R. Hudson, *Chem. Ind.*, 664 (1974).
- 7) C. B. E. Boyce and B. V. Milborrow, *Nature* (London), **208**, 537 (1965).
- 8) D. J. Finney, "Probit Analysis," 3rd Ed., Cambridge University Press, Cambridge, 1971, p. 318.
- 9) P. R. Chadwick, *Pyrethrum Post*, **7**, 25 (1963).