INSECT JUVENILE HORMONE ANALOGUES. II. SYNTHESIS AND BIOASSAY OF MULTIFUNCTIONAL JUVENOIDS.

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AMONG known insect juvenile hormones (JH), only juvenile hormone analogues (JHA) are considered to be promising for the insect pest control. Synthesis and biological evaluation for insect population control by JH analogues have been reported[1, 2]. Straight chain monoterpenes have shown little or no JH activity[3] but the activity can be induced by forming their aliphatic or aromatic derivatives[4–7]. Since several amides of *p*-substituted anilines and geraniol exhibit remarkable juvenile hormone activity on some hemipteran species[4, 6], it was felt worthwhile to prepare some amides of hydroxy-citronellylamine and different fatty acids (C_3-to-C_8).

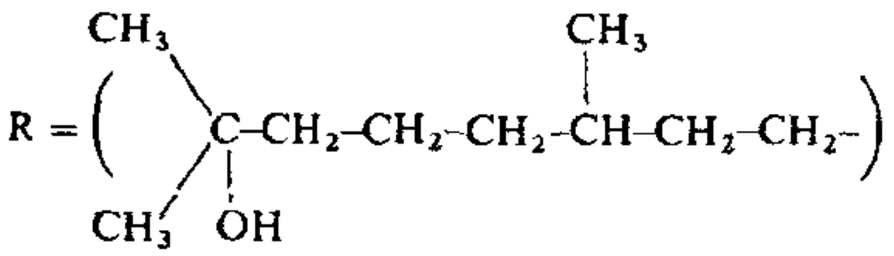
Hydroxycitronellal (S. H. Kelkar make, extra pure brand) was oximinated by hydroxylamine hydrochloride and soidum acetate to yield oxime in quantitative yield (Found: N, 7.23; $C_{10}H_{21}O_2N$ requires N, 7.48%. IR: ν max (smear), 3350–3250, 2950, 1710 and 1650 cm^{-1}). The oxime was reduced by Raney nickel alloy in presence of 10% sodium hydroxide solution[8] at 50°. The amine obtained was converted into its hydrochloride by HCl and extracted with ether to remove impurities and from aqueous portion, pure hydroxycitronellyl amine was isolated by methylene chloride extraction, after neutralization with bicarbonate. The amine was obtained as pale yellow coloured viscous liquid in 70% yield (b.p. 111–115°/2 mm; ^1H NMR in $CDCl_3$, δ ppm: 0.85, *d*, $CH–CH_3$; 1.17, *S*, *gem*-dimethyl; 2.30, *S*, OH, D_2O exchangeable; 2.58, *m*, (centre), CH_2NH_2). Using this amine, different amides were prepared from fatty acids using cyanuric chloride as condensing catalyst[9] which ensures better yields than other existing methods[10, 11]. The spectral data (IR, NMR and % N_2 by Kjeldahl method) of all amides were consistent with their structures. Since all amides have similar spectra, only the data for compound 3 (table 1) are given here as a representative case. (Found: N, 5.63; $C_{15}H_{31}O_2N$ requires N, 5.44%. IR: ν max (smear), 3450, 2920, 2860, 1710, 1680 cm^{-1}; ^1H NMR in $CDCl_3$, δ ppm: 0.90, *t*, terminal CH_3 and $CHCH_3$; 1.4, *d*, *gem* dimethyls, 2.2, *m* (centre), $COCH_2$ and $CH_2–C–OH$; 3.25 *m* (centre), $CH_2–NH–CO$; 8.6, *bs*, NHCO, D_2O exchangeable).

Bioassay

Juvenile hormone activity is tested on housefly *Musca domestica* third instar larvae about to pupate and scored as percent mortality over control experiments (non-emergence of adults from pupa).

In bioassay procedure each third instar housefly larva is treated with 25 μg test sample dissolved in 1 μl acetone by topical application (using Hamilton, 50 μl syrange with dispenser), and larval development is observed. Each batch contained 25 larvae and average of three such batches are combined to evaluate results. In the control run, each larvae is treated with 1 μl acetone topically, results of the test compounds are shown in table 1.

Table 1 *Juvenile hormone activity of some hydroxycitronellyl-amides (R ~ hydroxycitronellyl group)*



Compounds	Juvenile hormone activity *
RNHCO–CH_2–CH_3	+ +
RNHCO–$(CH_2)_2$–CH_3	+ +
RNHCO–$(CH_2)_3$–CH_3	+
RNHCO–$(CH_2)_4$–CH_3	–
RNHCO–$(CH_2)_5$–CH_3	–
RNHCO–$(CH_2)_6$–CH_3	–

* Juvenile Hormone Activity is tested on house fly third instar larvae and scored as percent mortality over control experiments (*non*-emergence of adults from pupa)
+ + Significant JH activity (about 80%)
+ Marginal JH activity (about 40–50%)
– No activity (less than 15% mortality)

It is observed that larvicidal activity of the analogues decreases as the carbon chain after amide bond increases to four. The activity is lost beyond five carbon chain. This is best explained as a balance between hydrophilic and lypophylic functions in the molecule related to the biological activity.

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ULTRA TRACE ANALYSIS BY DC POLAROGRAPHY USING CHEMICAL AMPLIFICATION REACTIONS

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THE need to estimate species at ppm and ppb levels and the necessity to analyse small quantities of samples demand analytical techniques with detection limits at sub-ppb level. Analytical signal can be enhanced by electronic amplification. But an electronic amplifier cannot distinguish between signal and background and can only amplify both, whereas to improve sensitivity or detection limit, it is necessary to selectively amplify the signal alone and not both[1]. Such a selective amplification can be realised by chemical amplification reactions.

Chemical amplification reactions can be defined as reactions in which the normal equivalence is altered in some way so that a more favourable measurement can be done. Amplification reactions have been reviewed by Belcher[2]. This communication is concerned with the improvement of detection limit of dc polarography by means of chemical amplification reactions.

For example, under suitable conditions 1 mol of orthophosphate reacts with 12 mol of ammonium molybdate to form the corresponding heteropoly molybdic acid (HPMA) complex. Hence, to estimate phosphorus, if one estimates the molybdenum content of HPMA, the signal is amplified by a factor of 12 atomic times (the mass amplification factor is 37.2). The signal can be enhanced further by coupling this with another cyclic regenerative type of chemical amplification reaction namely estimation of molybdenum by catalytic polarographic wave. The wave due to the reaction of Mo(VI) to Mo(V) in nitrate medium, known as the catalytic wave, exhibits a very much larger height than the diffusion-controlled wave, because of the cyclic regeneration of the Mo(VI) at the electrode surface by the chemical oxidation[3] of Mo(V) by No_3^-. The amplification factor for the second step is dependent on temperature. Under our experimental conditions[4] this factor is 40. By sequentially coupling these two chemical amplification reactions, the overall amplification becomes the product of the individual amplifications (for phosphorus, atomic amplification = 480; mass amplification = 1488). Such a large amplification factor dramatically improves the sensitivity and detection limit of dc polarography by more than two orders of magnitude.

The method has the potentiality of being versatile since at least 35 elements are known to form HPMA. Specificity is ensured by the conditions for HPMA formation and selective extraction of the same. The method involves the following steps.

X ⟶ Heteropolymolybdic acid (HPMA) formation with X as hetero atom ⟶ Selective extraction of HPMA into a suitable organic solvent ⟶ washing the organic solvent to remove the unwanted molybdate reagent which is also simultaneously extracted in the form of isopolymolybdic acid (IPMA) ⟶ Backstripping of HPMA into an aqueous alkali solution to release an equivalent amount of molybdenum corresponding to the original amount of X. ⟶ Estimation of molybdenum by catalytic dc polarographic wave.