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COMPARATIVE TOXICITY OF GAMMA-BHC, BROMOPHOS AND CARBARYL TO FIVE SPECIES OF INSECTS

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The relative toxicity of the three insecticides, gamma-BHC, Bromophos and Carbaryl varies from one species of insect to another. These insecticides were tested against five species of insects *A. domestica*, *T. castaneum*, *P. americana*, *B. germanica* and *C. analis*. Results showed that all the three insecticides are about equally toxic to *A. domestica* and *T. castaneum* but against *C. analis* gamma-BHC is much more toxic. Bromophos is the most toxic insecticide against *B. germanica*. Against *P. americana* gamma-BHC, is about three times as toxic as Bromophos and Carbaryl.

The present work is intended to demonstrate the relative toxicity of gamma-BHC, Bromophos and Carbaryl to five species of insects (*Periplaneta americana*, *Tribolium castaneum*, *Blatella germanica*, *Acheta domestica* and *Callosobruchus analis*) because no information on this aspect under conditions prevailing in Pakistan was available.

The three insecticides used belong one each to chlorinated hydrocarbons, organophosphate and carbamate groups. In the first group, gamma-BHC was selected because it is being produced in Pakistan. From the other two groups Bromophos and Carbaryl were respectively selected because of their quite low toxicity to mammals. The safety factor is important because the insects selected for the present evaluation are generally found in households and relatively safe insecticides are desirable for their control to avoid hazards to human beings. The reason for using these insects was their notorious ability to survive under adverse conditions of humidity and temperature and scarcity of food. Studies on the relative toxicity of some insecticides to the boll-worm and tobacco bud worm were reported by Brazzel *et al.*[1] The response of the various instars of the boll-worm and tobacco bud-worm to DDT and Endrin applied topically was reported by McPherson *et al.*[2] Gast[3] and Treece[4] who compared the susceptibility of the face fly *Musca autumnalis* and the housefly *M. domestica* using a microapplicator. Soliman[5] determined the toxicity of gamma-BHC and DDT to *Hodotermes ochreceus* (Brun) by topical application and found BHC more effective than DDT. Hamilton[6] found LD_{50}'s for Aldrin against resistant larvae and adult of Western corn root-worm by microapplication. Lemon[7] evaluated in the laboratory Malathion, Bromophos and Fenitrothion for use against beetles infesting stored product by means of topical application technique. Leigh *et al.*[8] compared the topical toxicity of chlorinated hydrocarbons, organophosphates and carbamate insecticide and found that chlorinated hydrocarbons as a group were less effective than the other two groups of compounds compared; probably due to population resistance to most organochlorine insecticides.

Material and Methods

Tests Insects.—*P. americana* and *B. germanica* were reared on wheat bran, *T. castaneum* on wheat flour and *A. domestica* on wheat flour mixed with fish meal. *C. analis* was raised on gram at 30–35°C and 50–70% R.H.

Treatment of Insects.—Test insects of known age were inactivated by cooling to −5°C before treating individually with measured drops of an acetone solution of insecticide from an Arnold hand microapplicator. 1–2 day-adult *C. analis* and 1–2-month old adult *T. castaneum* were treated with 0.5 µl of insecticide solution applied to ventral side of the thorax. 2–3-month old *A. domestica* and 5–7-month old nymph of *P. americana* were treated with 1.0 µl and 3–5-month old *B. germanica* with 0.5 µl of insecticide solution at the base of coxa of hindleg.

P. americana were kept in petri dishes and *A. domestica* in 100-ml glass beakers closed with muslin. The other three species of insects were kept in $2\frac{1}{2} \times 1$ in tubes covered with muslin held in place with rubber bands.[1] Three batches of insects were used for each treatment. Controls, both untreated and treated only with the solvent alone, were used concurrently in each test. The tubes, dishes and beakers containing the test insects were kept in large glass jars (18 × 8in) immersed in a constant temperature water bath maintained at 30° ± 1°C as no alternate constant temperature facilities were available. This arrangement became necessary when it was observed that variations in temperature affected the toxicity of pesticides used.[9] Preliminary tests were made with insecticide solutions with the concentrations differing by a factor of 10. Then five concentrations differing by a factor of 2 were used to determine the LC_{50} of each insecticide. Each test was repeated at least three times. All the three insecticides were tested at the same time

TABLE 1.—COMPARATIVE EFFECTS OF THREE DIFFERENT STANDARD INSECTICIDES OF FIVE SPECIES OF INSECTS.

Insects	Insecticides	Heterogenity	Regression equation	LC_{50} (%)	Fiducial limit	Volume applied (µl)
A. domestica	Gamma-BHC	=0.150	$Y=2.05x+0.34$	0.4519	0.9949 0.2052	
	Bromophos	=0.026	$Y=2.78x+3.08$	0.4875	0.6998 0.3396	1.0
	Carbaryl	=0.240	$Y=4.5x+1.69$	0.5370	0.8337 0.3459	
P. americana	Gamma-BHC	=0.023	$Y=1.56x+3.40$	1.0600	2.0180 0.5433	
	Bromophos	=0.604	$Y=11.06x+14.73$	3.0900	4.8530 1.9680	1.0
	Carbaryl	=1.019	$Y=3.98x-0.09$	3.1410	4.7640 2.0700	
B. germanica	Gamma-BHC	=1.430	$Y=1.92x+4.12$	0.2884	0.5188 0.1603	
	Bromophos	=0.300	$Y=3.52x-1.30$	0.0626	0.0803 0.0452	0.5
	Carbaryl	=0.018	$Y=2.29x+2.80$	0.9120	1.4450 0.5675	
T. castaneum	Gamma-BHC	=0.418	$Y=2.45x+3.05$	0.0062	0.0090 0.0042	
	Bromophos	=1.711	$Y=2.87x+2.38$	0.0081	0.0106 0.0062	0.5
	Carbaryl	=0.956	$Y=1.94x+3.47$	0.0062	0.0087 0.0043	
C. analis	Gamma-BHC	=0.090	$Y=6.99x+0.64$	0.0042	0.0046 0.0037	
	Bromophos	=0.205	$Y=4.67x+2.75$	0.0303	0.0356 0.0257	0.5
	Carbaryl	=0.330	$Y=1.42x+2.94$	0.2818	0.1660 0.0479	

against any one species of insects and results were calculated and compared by probit analysis.[10]

Results and Discussions

The relative toxicity of the three insecticides gamma-BHC, Bromophos and Carbaryl varies from one species of insects to another.

Detailed results of the probit analysis of the insecticides tested are presented in Table 1. Table 2 gives a brief summary of the relative toxicities of the three compounds tested against all the five insect species.

From the tables it is evident that all the three insecticides are about equally toxic to *A. domestica* and *T. castaneum*, gamma-BHC is about three times as toxic to *P. americana* as Bromophos and Carbaryl, which are about equally toxic to this insect. Against *C. analis* gamma-BHC is relatively much more toxic (ten times) than Bromophos, which in turn is 4–5 times more toxic than Carbaryl. Against *B. germanica*, Bromophos is 4–5 times more toxic than BHC which is about three times more toxic than Carbaryl. Thus, against four of the five species used, gamma-BHC is either more toxic or as toxic as the other two compounds and only against *B. germanica* Bromophos is much more toxic (4–5 times) than gamma-BHC.

Against two species of insects, *B. germanica* and *C. analis*, Carbaryl is much less toxic than either gamma-BHC or Bromophos. The amounts of each insecticide needed to kill each of the five species of insects tested differ from species to species. But with the more generally toxic compounds, i.e. gamma-BHC and Bromophos, the larger the insect the more insecticide is required to kill and on a weight-by-weight basis approximately the same amount of insecticide is needed for all species. However, relatively much larger doses of Carbaryl are needed to kill *C. analis* and *B. germanica* which are much more resistant to this insecticide than the other three species.

TABLE 2.—RELATIVE TOXICITIES OF GAMMA-BHC, BROMOPHOS AND CARBARYL.

Insect	Insecticide LD_{50} µg/insect			Approximate wt of insect (g)
	BHC	Bromophos	Carbaryl	
A. domestica	4.5	4.8	5.3	0.3
B. germanica	1.4	0.3	4.5	0.068
P. americana	10.6	30.9	31.4	0.58
T. castaneum	0.03	0.04	0.04	0.0018
C. analis	0.04	0.2	1.4	0.007

From our results Carbaryl seems to be the least effective insecticide tested as it was never more toxic and sometimes much less toxic than gamma-BHC or Bromophos. There is little difference between gamma-BHC and Bromophos which are equally effective against two species i.e. *A. domestica* and *T. castaneum*, while gamma-BHC is three times more toxic to *P. americana* and ten times more toxic to *C. analis* than Bromophos, but Bromophos is four times more toxic than gamma-BHC to *B. germanica*. Thus, on the basis of toxicity to insects there is no reason to employ Carbaryl in preference to either gamma-BHC or Bromophos. Thus, one would expect to choose Carbaryl for use against some of the insects in preference to the other insecticides only on the basis of cost or some other property like lower mammalian toxicity or greater persistence which might confer some other advantages in use.

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