AN INDIGENOUSLY DEVELOPED INSECTICIDAL AEROSOL

R. N. Varma*, B. Mahadevan**, A. K. Ganguly† & N. D. P. Karani‡

Armed Forces Medical College, Poona

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A total of 6 "Test" insecticidal aerosols (TA-I to VI) indigenously produced were tested during the years 1966-67 as suitable replacements for imported aerosols. TA-I produced deep yellow staining and a yellowish spray mist. Its capacity was only 120 ml fluid. TA-II had a plastic nozzle valve, defective delivery rate and shorter spray life. TA-III types II and III containing modified aerosol formulation with "Esso solvent 3245" and mineral turpentine oil (Burmah Shell) and Freon 12 and 11 (all indigenous) were comparable to the "SRA" in insecticidal efficacy. The container was also manufactured in the country and it compared well with the "SRA" in construction, resistance against rough usage and mechanical function. They were both finally approved for introduction in the services as replacements for imported aerosols. TA-IV performed well in insecticidal assessment, but the aerosol formulation was a little toxic and the container has some defects in construction and mechanical function. TA-V and VI were similar to TA-III types II and III respectively.

The insecticidal aerosol, formerly called "Aerosol Bomb", is primarily intended for an expedient and instantaneous control of insect vectors, usually within confined spaces and operates mainly by virtue of its pyrethrum content. The Aerosol Bomb was largely in vogue during World War II for the destruction of mosquitoes and flies in dining halls, cook houses and tents. It was of USA manufacture, and even today some of these are used occasionally in the Armed Forces. During the past years the insecticidal aerosol has found a significant place in the disinfection of aircrafts used in International flights, especially as a international measure prescribed for the control of yellow fever[1].

To meet the current need for an insecticidal aerosol in the Armed Forces, a satisfactory indigenous substitute has now been evolved.

A large number of indigenously developed prototypes of insecticidal aerosol have already been tested and reported[2,3]. The shortcomings of these prototypes have now been overcome and defects rectified by a sustained collaborative effort between the Armed Forces Medical College, Poona, Chief Inspectorate of General Stores, Kanpur and Trade.

This paper deals with the performance tests carried out at the Armed Forces Medical College, Poona on six prototypes of the insecticidal aerosol.

MATERIALS AND METHODS

Test Insecticidal Aerosols

The six types of aerosols (a) to (f) described as under were tested :

* Lt. Col. R. N. Varma, Reader in Preventive Medicines.
** Brig. B. Mahadevan, Dean Graduate Wing.
† Lt. Col. A. K. Ganguly, ASSO. Prof., Preventive Medicines.
‡ Maj. Gen. N. D. P. Karani, Commandant.

Fig. 1—Test Aerosol I

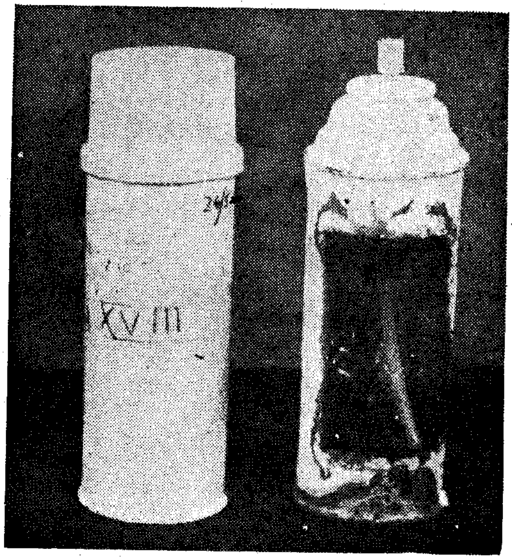

Fig. 2—Test Aerosol IV

(*a*) Light weight aerosol insecticide sprayer supplied by M/s Vibropharma (Private) Ltd., Bombay hereinafter, referred to as "Test Aerosol-I" (TA-I) (Fig. 1).

It was an all-metal container, with 120 ml fluid capacity. The aerosol formulation used was similar to that of TA-IX (cf Discussion), except that it contained "Esso solvent 2445" in place of deobase oil and Freon 12 and Freon 11 in place of dichloro-di-fluoromethane and trichloro-fluoro-methane respectively.

(*b*) Light weight expendible aerosol insecticide sprayer supplied by M/s Everest Refrigerants Ltd., Bombay, hereinafter, referred to as "Test Aerosol II" (TA-II). It was an all metal container similar to TA-IX but with a plastic nozzle. Three types of TA-II were received, one containing aerosol formulation with deobase oil and the other two containing "Esso solvent 2445" and mineral turpentine oil respectively in lieu of deobase oil.

(*c*) Light weight aerosol insecticide sprayer supplied by M/s Vibropharma (Private) Ltd., Bombay, hereinafter, referred to as "Test Aerosol III" (TA-III). It was an all metal container with metal nozzle and concave bottom (similar to TA-IX).

Three different types of TA-III were received each containing the following aerosol formulation:

Type	Pyrethrum extract (20% pyrethrins)	DDT Technical	Xylene	Freon 11 & 12 (equal quantity each)	Deobase oil	Esso solvent 2245	Mineral terpentine oil (Burmah Shell)
				% W/W			
I	2·0	3·0	7·5	84·6	2·9	Nil	Nil
II	2·0	3·0	7·5	84·6	Nil	2·9	Nil
III	2·0	3·0	7·5	84·6	Nil	Nil	2·9

(d) Aerosol dispenser developed at Regional Research Laboratory (RRL), Jammu and supplied by Director of Research (Laboratories), R&D Organisation, Ministry of Defence, New Delhi, hereinafter, referred to as "Test Aerosol-IV" (TA-IV) (Fig. 2).

It was a metal container with a plastic nozzle and a loose plastic cap. Its aerosol formulation was also developed at RRL, Jammu containing only 0·2% pyrethrins as against 2% in TA-IX.

(e) Light weight expendible aerosol insecticide sprayer supplied by M/s Spredaroma (Private) Ltd., Calcutta, hereinafter, referred to as "Test Aerosol V" (TA-V). The aerosol container was similar to TA-IV and the aerosol formulation was the same as that of Type III of TA-III.

(f) Light weight aerosol insecticide sprayer supplied by M/s Everest Refrigerants Ltd., Bombay, hereinafter, referred to as "Test Aerosol VI" (TA-VI).

The aerosol container was similar to TA-IX and the aerosol formulation conformed to that of (Type II of TA-III).

Test Procedure

The test aerosols were evaluated for constructional soundness, resistance against rough usage, mechanical efficiency, biological performance and toxicity risk against the WHO Standard Reference Aerosol ('SRA'), (Fig. 3) in accordance with the specifications and methods[1] recommended by WHO in 1961 and reported earlier by Karani *et al*[2] .

RESULTS

TA-I : The aerosol formulation produced deep yellow staining and yellowish spray mist. It was, therefore, not tested any further.

TA-II : All the three types were tested for their biological performance (only two replicates) and the following defects were found to exist and therefore, further testing was abandoned.

(a) The plastic nozzle valve bent on pressure giving an erratic discharge.

(b) The discharge rate was twice that of the WHO specification (1·0±0·2 gm per second).

(c) The aerosol completely exhausted itself in 3 minutes whereas the spray life in the "SRA" is 7 minutes and 40 seconds.

TA-III : All the three different types (Types I, II and III) of this were tested for their insecticidal efficacy. The results are shown in Tables 1 to 3.

It will be seen from the data given in Tables 1, 2 and 3 that the biological efficacy of Types I, II and III of TA-III was 98·7, 97·8 and 99·6% respectively taking the efficacy of the "SRA" as 100.

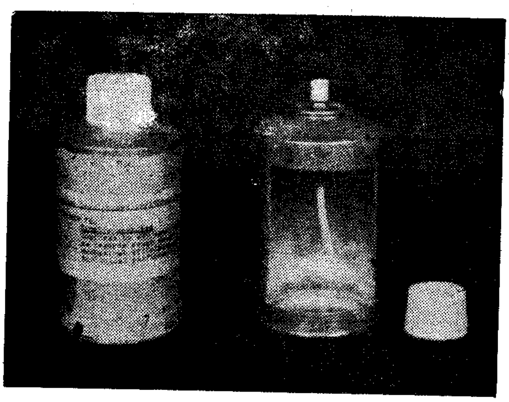

Fig. 3—WHO Standard Reference Aerosol

TABLE 1

MORTALITY OF *Musca nebulo* EXPOSED FOR 10 MINUTES TO (*i*) STANDARD REFERENCE AEROSOL (SRA) AND (*ii*) "TEST" AEROSOL BY EXPOSING 100 OF THEM IN EACH CASE. COMPARATIVE EFFICIENCY OF THE AEROSOLS (TA-III, TYPE I)

Replicate No.	Aerosol tested	Weight of Aerosol dispensed (gm)	Percentage Killed	Comparative efficiency of TA-III type I taking SRA as 100
1	SRA TA III (Type I)	6 5	88·0 91·0	103·4
2	SRA TA-III (Type I)	6 6	90·0 90·0	100·0
3	SRA TA-III (Type I)	6 6	90·0 90·0	100·0
4	SRA TA-III (Type I)	6 6	91·0 89·0	97·8
5	SRA TA-III (Type I)	6 5	90·0 87·0	96·7
6	SRA TA-III (Type I)	6 6	92·0 88·0	95·7
7	SRA TA-III (Type I)	6 6	92·0 90·0	97·8
8	SRA TA-III (Type I)	6 6	91·0 89·0	97·8
Average	SRA TA-III (Type I)	6 6·75	90·5 89·3	98·7

A "Test Aerosol" or (TA) is considered equal to "SRA" if the percentage mortality produced by it is within 5% of the "SRA". Since the percentage mortality produced by all the three types of TA-III was within 5% of the "SRA", their biological performance was satisfactory.

TA-IV : It was found to have the following defects :

(*a*) The aerosol container did not conform to the WHO "SRA" in design, construction and capacity.

(*b*) The spray nozzle was made of plastic and, therefore, emitted an erratic discharge.

(*c*) The plastic cap of the container fitted very loosely and touched the nozzle cap.

(*d*) The insecticidal formulation produced yellow staining.

TABLE 2

MORTALITY OF *Musca nebulo* EXPOSED FOR 10 MINUTES TO (*i*) STANDARD REFERENCE AEROSOL (SRA) AND (*ii*) "TEST" AEROSOL (TA-III-TYPE II) BY EXPOSING 100 OF THEM IN EACH CASE. COMPARATIVE EFFICIENCY OF THE AEROSOLS

Replicate No.	Aerosol tested	Weight of aerosol dispensed (gm)	Percentage Killed	Comparative efficiency of TA-III type II taking SRA as 100
1	SRA TA-III (Type II)	6 6	88·0 89·0	101·1
2	SRA TA-III (Type II)	6 5	90·0 82·0	91·1
3	SRA TA-III (Type II)	6 4	90·0 84·0	93·3
4	SRA TA-III (Type II)	6 4	91·0 89·0	97·8
5	SRA TA-III (Type II)	6 5	90·0 91·0	101·1
6	SRA TA-III (Type II)	6 6	92·0 90·0	97·8
7	SRA TA-III (Type II)	6 6	92·0 91·0	98·9
8	SRA TA-III (Type II)	6 6	91·0 92·0	101·1
Average	SRA TA-III (Type II)	6 5·25	90·5 88·5	97·8

It was contended on behalf of the suppliers that as the aerosol formulation (containing 0·2% pyrethrins) was specially developed at RRL, Jammu its insecticidal efficacy should be determined notwithstanding the above defects in construction and performance. Consequently, its biological performance was tested and the results are shown in Table 4.

It will be seen from Table 4 that the biological efficacy of TA-IV came to 100·4% of the "SRA" which is very satisfactory. However, the aerosol formulation produced considerable irritation in the eyes, nose and throat of the subjects exposed to it for a period of ten minutes during the trials in each of the eight replicates. This aspect needs further investigation.

TA-V and TA-VI : These are similar to Type III and II respectively of TA-III in construction and performance.

TABLE 3

MORTALITY OF *Musca nebulo* EXPOSED FOR 10 MINUTES TO (*i*) STANDARD REFERENCE AEROSOL (SRA) AND (*ii*) "TEST" AEROSOL (TA-III-TYPE III) BY EXPOSING 100 OF THEM IN EACH CASE. COMPARATIVE EFFICIENCY OF THE AEROSOLS

Replicate No.	Aerosol tested	Weight of aerosol dispensed (gm)	Percentage Killed	Comparative efficiency of TA-III type III taking SRA as 100
1	SRA TA-III (Type III)	6 6	88·0 86·0	97·7
2	SRA TA-III (Type III)	6 6	90·0 89·0	98·9
3	SRA TA-III (Type III)	6 6	90·0 91·0	101·1
4	SRA TA-III (Type III)	6 6	91·0 90·0	98·9
5	SRA TA-III (Type III)	6 6	90·0 91·0	101·1
6	SRA TA-III (Type III)	6 6	92·0 93·0	101·1
7	SRA TA-III (Type III)	6 6	92·0 89·0	96·7
8	SRA TA-III (Type III)	6 6	91·0 92·0	101·1
Average	RA TA-III (Type III)	6 5·87	90·5 90·1	99·6

DISCUSSION

Candidate aerosols[1] I—V were glass cum cardboard/metal packs with the aerosol formulation in a soda water type glass bottle. These prototypes had some inherent defects in their structural performance such as defective rate of discharge, erratic behaviour of the plastic sprary nozzle, leakage of the insecticide during and after operation, displacement and liability to damage of the bottle container, denting of the outer cover during rough usage, bulk and extra weight. It was stressed that to attain the required WHO specifications in biological efficacy and structural performance, an all metal container with a metal nozzle on the pattern of WHO "SRA" should be designed.

TABLE 4

MORTALITY OF *Musca nebulo* EXPOSED FOR 10 MINUTES TO (*i*) STANDARD REFERENCE AEROSOL (SRA) AND (*ii*) "TEST" AEROSOL (TA-IV) BY EXPOSING 100 OF THEM IN EACH CASE. COMPARATIVE EFFICIENCY OF THE AEROSOLS

Replicate No.	Aerosol tested	Weight of aerosol dispensed (gm)	Percentage Killed	Comparative efficiency of (TA-IV) taking SRA as 100
1	SRA	6	93·0	98·9
	TA-IV	6	92·0	
2	SRA	6	94·0	98·9
	TA-IV	6	93·0	
3	SRA	6	92·0	98·9
	TA-IV	6	91·0	
4	SRA	6	94·0	96·8
	TA-IV	6	91·0	
5	SRA	6	90·0	106·7
	TA-IV	6	96·0	
6	SRA	6	93·0	101·1
	TA-IV	6	94·0	
7	SRA	6	93·0	103·2
	TA-IV	6	96·0	
8	SRA	6	95·0	98·9
	TA-IV	6	94·0	
Average	SRA	6	93·0	
	TA-IV	6	93·4	100·4

Subsequently, Mahadevan *et al*[3] (in press) reported on nine prototype aerosols (Test aerosols I—IX) which were all metal containers with a metal nozzle and from which the soda water type glass bottle container and the plastic nozzle were eliminated. Test aerosols (TA-I to TA-VII) had some mechanical defects in their structural performance and their biological efficacy was not tested as the aerosol formulation produced a yellowish tinge and spray mist, which was due to the unrefined quality of pyrethrum extract. This defect was subsequently removed by incorporating in the insecticide formulation (TA-IX) deluxe-decolourised pyrethrum extract (20% pyrethrins) manufactured in the country.

Fig. 4—Test Aerosol IX

TA-IX (Fig. 4) was evaluated in detail against the "SRA" in accordance with WHO specifications. It is an all metal container, with a metal nozzle and cylindrical in shape with a concave bottom. It has a multiple delivery non-refillable aerosol with a discharge rate of 1·0 g per second and a spray life of approximately 7 minutes. It has a fluid capacity of 340 ml. The construction is sound and withstands rough usage. Mechanical efficiency is also good. The valve is protected against accidental discharge and there is no leakage during and after operation. The aerosol formulation is free from any toxicity. 80% of aerosol (W/W) consists of droplets not exceeding 28 microns in diameter and 90% (W/W) consists of droplets not exceeding 29 microns in diameter.

The insecticidal efficacy of TA-IX is 100·9% of "SRA".

The aerosol formulation is as under :

	%W/W
Pyrethrum extract (20 % pyrethrins)	2·0
DDT Technical	3·0
Xylene	7·5
Odourless petroleum distillate (deobase oil)	2·9
Odourless kerosene	
Dichloro-difluoromethane (Freon 12)	42·3
Trichloro-fluoromethane (Freon 11)	42·3

The formulation conforms to that of the "SRA" (WHO Formula No. CMR/ODC/I except that it contains 2% by weight of 20% pyrethrins against 1·6% by weight of 25% pyrethrins in the "SRA" but this modification does not affect its insecticidal efficacy.

In all respects including construction, mechanical function, insecticidal efficacy and toxicity TA-IX compares well with the "SRA" and was therefore, accepted for introduction in the Services as a suitable substitute for imported aerosols (Mahadevan *et al*[3], in press).

Subsequently, the authors were informed that introduction of TA-IX in the Services had been held in abeyance as the valve, deobase oil and Freon gas used in it were imported[4]. Efforts were made by Chief Inspectorate of General Stores, Kanpur to establish indigenous production and find suitable substitutes for these components. It was reported that "Esso solvent 2445" and mineral turpentine oil available in the country are the nearest substitutes for deobase oil. Indigenous production of Freon gas and metal valves was also reported. The prototypes described in this paper had the above indigenous materials incorporated. Of the six prototypes tested, only TA-III came upto the required standards both in biological efficacy and structural performance. The substitution of "Esso solvent 2445" and mineral turpentine oil (Burmah Shell) for deobase oil and Freon 12 and Freon 11 for dichloro-difluoromethane and trichloro-fluoromethane in the aerosol formulation does not affect its insecticidal efficacy.

TA-III was thus, an entirely indigenous production. As it has a metal container similar to TA-IX, and in view of its above-mentioned merits, (Types II and III) of TA-III were approved for introduction in the services.

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