Antibiotic Paper Packs: Another Method of Prolonging Drug Treatment in Honey Bee Colonies[1, 2]

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ABSTRACT

NINE types and sizes of ANTIBIOTIC PAPER PACKS were tested in *healthy* colonies of honey bees (*Apis mellifera* L.) to determine which would prolong most a single treatment of drugs.

The most practical size of pack contained 15 grams of a dry mixture of oxytetracycline, sulfa, and powdered sugar though those containing 22.5 or 30 grams were also acceptable. The 15-gram pack made the drug mix available to the bees for an average of 4 to 17 days depending on the type and quantity of paper used in making the pack and on environmental factors.

The length of time ANTIBIOTIC PAPER PACKS remained in a colony was influenced by external environmental factors such as nectar flow and within the hive by the position of the pack. Packs wedged between the brood frames were removed in one day or less.

Absorbent paper towels and sheets of newspaper were both satisfactory types of paper for making the packs.

INTRODUCTION

In a recent article, Wilson *et al.* (1973) reported the successful treatment of American foulbrood in colonies of honey bees, *Apis mellifera* L., with three types of ANTIBIOTIC PAPER PACKS, an experimental method of making antibiotics available to such colonies. The paper packs contained either oxytetracycline (Terramycin®) at two concentrations or oxytetracycline combined with sodium sulfathiazole. The drugs were mixed with powdered sugar, wrapped in paper towels, and administered in dry form. The packs proved reasonably beneficial in controlling the spread of the pathogen *(Bacillus larvae White)* within severely diseased colonies, and they were very successful in preventing the disease in colonies that were exposed naturally to the spores of *B. larvae*.

In the study reported in this article, nine types and sizes of ANTIBIOTIC PAPER PACKS were tested in *healthy* colonies of honey bees to determine how long a single application remained in a colony. These packs were originally developed and tested by a commercial beekeeper[3] and later by the U.S. Department of Agriculture, Bee Disease Investigations Laboratory at Laramie, Wyoming.

MATERIAL AND METHODS

The basic formulation used in a single 15-gram Antibiotic Paper Pack included 2.6 grams (about 1.25 level teaspoons) of TM 10 (animal formulation of oxytetracycline in soybean meal) and 2.4 grams (1 level teaspoon) of sodium sulfathiazole mixed thoroughly with 10 grams (1.5 level tablespoons) of powdered sugar (total quantity of the mixture was about 2.3 level tablespoons). Packs of other sizes contained a total of 7.5, 22.5, 30, 45, or 60 grams of the drug mixture in the same proportions of TM 10, sulfa, and powdered sugar.

The 15 grams (2.3 tablespoons) of the drug and sugar mixture was spread out uniformly on two 11 x 11 inch

Fig. 1. The tablespoons of the Terramycin-sulfa powdered-sugar mix were placed on two sheets of absorbent-type paper towels. The mixture was spread over the towels in a uniform layer.

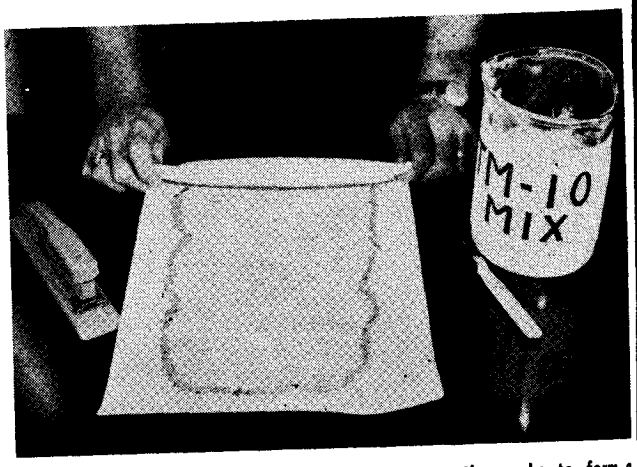

Fig. 2. The towels were folded over continuously to form a 2-in-wide packet with alternating layers of antibiotic powdered-sugar mixture and paper.

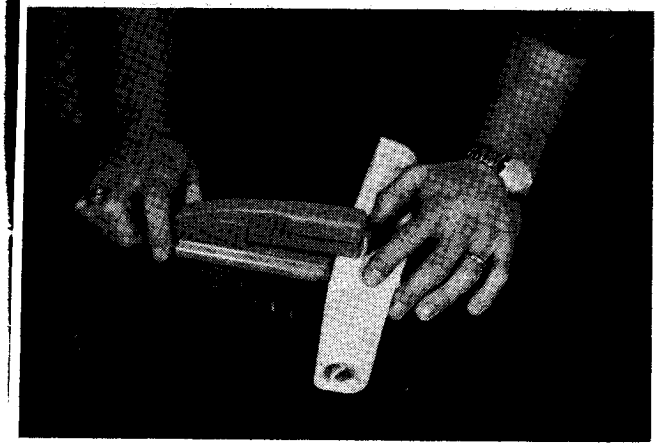

Fig. 3. The Antibiotic Paper Pack was stapled in the center to keep it from unfolding during storage and while in the colony. Also, both ends were folded over and stapled to prevent the mixture from falling out.

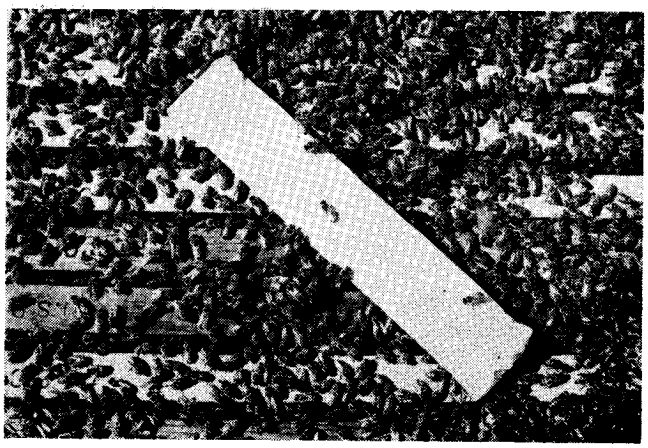

Fig. 4. Completed Antibiotic Paper Packs were placed on the top bars directly over the broodnest. Adult worker bees in the broodnest had ready access to the pack.

sheets of household-type absorbent paper toweling (Fig. 1) or sometimes on large (12 x 15 inch) sheets of newspaper. The number of sheets of paper toweling used in constructing the packs varied from one to four. Packs made from newspaper were constructed with either one or two sheets.

After the mixture was spread out, the paper was folded over continuously in a 2-inch band (Fig. 2) and hand pressed into a flattened pack so layers of drug mixture were alternated with sheets of paper. The folded pack was stapled in the center of one edge and on each end to prevent unfolding (Fig. 3). Completed packs (½ x 2 x 10 inches) were stored at room temperature for one to several days before they were given to the colonies. Packs containing larger amounts of drug mixture were thicker; the 7.5-gram pack was thinner.

When Antibiotic Paper Packs were given to a colony, they were placed on the top bars above the broodnest (Fig. 4), except in a few special tests where the packs were wedged down between the brood frames. If the broodnest was in two hive bodies, the pack was placed on the top bars of the lower hive body. Control colonies were each treated by dusting 30 grams of powdered-sugar drug mixture over the top bars of the lower hive body.

Four separate tests were made with a total of 19 disease-free colonies located in two apiaries. Some of the colonies were used more than once in the different tests. Only healthy colonies were used to reduce the variability between populations due to the deleterious effects of diseases such as AFB on broodrearing and ultimately on the strength of the adult population. At the beginning (June) and at the end (August) of the study, the colonies were all rated as "strong" in adult populations. At the end of the summer, all colonies had large broodnests in two deep 10-frame hive bodies with one or more deep supers for the storage of honey.

During a test, each colony was examined twice weekly, and in some cases every day, to determine the number of days before *all* the pack had been consumed or removed from the hive. The range and average (mean) number of days that the packs remained in a strong colony was calculated from these data. Then the prolongation value of the various types of pack could be determined as the average number of days 1 gram of drug mixture remained in the hive by dividing the average number of days by the quantity of drug mixture used in the pack. Cursory observations were also made of the gen-

Table 1. Length of time Antibiotic Paper Packs of various sizes remained in healthy colonies of honey bees.

No. of sheets of Paper toweling (11" X 11")	No. of sheets of Newspaper (12" X 15")	Weight of drug-powdered sugar mixture per pack (grams)	No. colonies treated	Duration Range (days)	Duration Average (days)	Average No. days per gram of drug-mix consumed
			Series I			
1	....	7.5	3	3 - 5	4	0.5
2	....	15.0*	3	6 - 12	9	0.6
3	....	22.5	3	12 - 23	16	0.7
4	....	30.0	3	16 - 35	26	0.9
0 (Controls)**	....	30.0	3	2 - 4	3	0.1
			Series II			
2	....	15.0*	3	8 - 20	16	1.1
2	....	30.0	3	10 - 31	17	0.6
2	....	45.0	3	15 - 35	25	0.6
2	....	60.0	3	31 - 35	33	0.6
			Series III (Harnden yard)			
....	1	15.0*	4	4 - 4	4	0.3
....	2	15.0*	3	3 - 6	4	0.3
			Series IV (Johnson yard)			
....	1	15.0*	2	8 - 13	11	0.7
....	2	15.0*	2	10 - 24	17	1.1

* Basic formulation of oxytetracycline, sulfathiazole, and powdered sugar equal to 2 1/3 level tablespoons.
** Drug formulation applied as a dust sprinkled on the top bars.

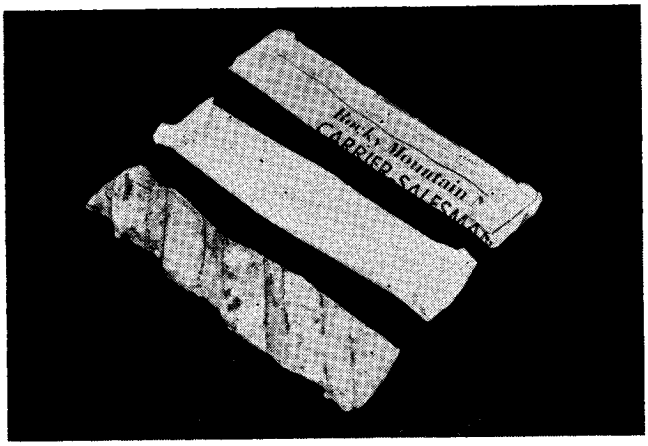

Fig. 5. Absorbent towels used in the center; newspaper used for the upper pack, the lower pack colony propolized after sugar sirup dripping on it from a feeder can had caused the pack to harden.

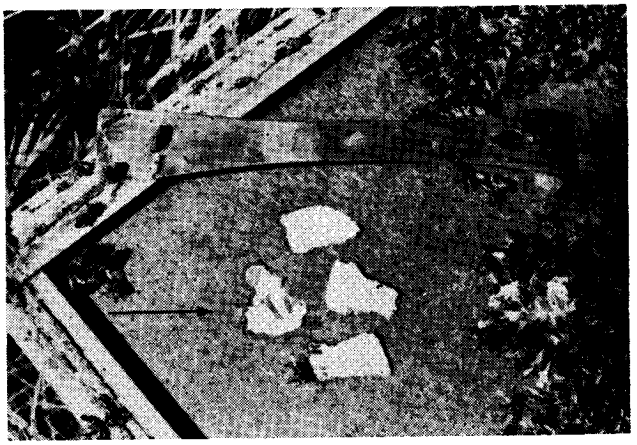

Fig. 6. In some colonies the adult bees chewed off large pieces of paper and deposited them on the ground in front of the hive. In other colonies the workers shredded the paper during removal.

eral behavior of colonies in response to the presence of a pack and the effects of the location of the pack within the hive on the removal of the pack by the adult worker bees.

RESULTS AND DISCUSSION

The Antibiotic Paper Packs were developed to "stretch" a given treatment over an extended period so as to provide a constant supply of drugs for a longer time than is accomplished by a single dusting with an antibiotic.

The three sizes of packs that most efficiently extend a single treatment (Table 1) were the 15, 22.5, or 30 grams of drug mixture enclosed in 1 to 4 sheets of paper. In series I, II, and IV, the bees consumed or removed the drugs from the packs at the approximate rate of 1 gram every ½ to 1 day except the controls. However, the 15-gram pack made with two sheets of paper (either newspaper or toweling) was judged to be the most practical: a visible residue of the drug mixture remained in these colonies for averages of 9 to 17 days depending on the type of paper and the number of sheets of paper and various environmental factors. In the third series, the rate of consumption of the 15-gram packs was unduly rapid — about 3½ grams per day (Table 1, Series III). In the control colonies where the drug mixture was applied as dust sprinkled once on the top bars, a visible residue lasted an average three days, a period that would be ineffective in disease control.

The smallest pack (7.5 grams) and those larger than 30 grams were about equally beneficial in the distribution of the drugs based on the rate of drug consumption (Table 1). The larger sizes (45 and 60 grams) lasted longer but were too bulky to be of practical value: the 15-gram packs (½-inch thick) fitted conveniently in the space between the frames of an upper and a lower hive body, whereas the larger packs were too thick, and caused an undesirable separation of the two hive bodies. The 7.5 gram pack fitted well but was of little value since the contents lasted only from 3 to 5 days. Also, packs made with more paper caused a slower rate of consumption of packs containing equal amounts of drug mix. For example, 30-gram packs made with four sheets of toweling lasted an average 26 days, but similar packs made with two sheets lasted only 17 days. This same trend held true when 15-gram packs made with one sheet were compared with packs made with two sheets of newspaper (Table 1, Series IV). Also, Antibiotic Paper Packs made of newspaper were comparable to packs made of absorbent towels (Fig. 5) in rate of consumption in series I, II, and IV (Table 1). The packs consumed at the fastest rate (Series III) were made of newspaper.

As noted, the rate of removal of the paper packs in series III was greatly accelerated. The contrast is especially apparent between series III and IV which were made with colonies in two well-separated apiaries. However, at the Johnson apiary, the bees were actively collecting nectar and pollen from minor spring sources during the tests; at the Harnden apiary, there was a near dearth of nectar and pollen. Then, since the colonies were of nearly equal strength and the packs were the same size, the factor that appeared to have the most influence on the rate of removal of the packs was the availability of natural nectar and pollen. Colonies that were occupied with gathering nectar and pollen did not remove the Antibiotic Paper Packs nearly as rapidly (less than one week versus more than two weeks). Also, the rate of removal of the packs was influenced by the location of the paper pack within the hive. The top bars between two hive bodies seems to be the most suitable place. If packs were wedged down between the frames of the broodnest, the worker bees tore them out and removed the paper and chemicals in one day or less.

The behavior of the worker bees differed between colonies during the removal of the paper from the packs. The workers in some colonies removed large pieces of paper about one inch in diameter (Fig. 6) and deposited it outside the hive; others shredded the paper and either left it inside the hive on the bottomboard or dropped it outside the entrance. However, as the paper was removed, the various layers of drug mixture were exposed, and the worker bees appeared to ingest the powder.

The Antibiotic Paper Packs were tested by the USDA during only one summer but in two geographical regions of Wyoming. The packs were also used successfully by at least two commercial beekeepers in Colorado.

ACKNOWLEDGMENT

L. Dooley Toyne, a commercial beekeeper from Sedgwick, Colorado, is thanked for his contributions to the early testing of Antibiotic Paper Packs.

REFERENCE

Wilson, W. T., Elliott, J. R., and Hitchcock, J. D. 1973. Treatment of American foulbrood with antibiotic extender patties and antibiotic paper packs. Amer. Bee J. **In Press.**

FOOTNOTES

[1] The term **antibiotic** is used in its broadest sense to include antimicrobial compounds of both natural and synthetic origin.

[2] Mention of a proprietary product in this paper does not constitute an endorsement of this product by the U. S. Department of Agriculture. The data do not constitute a recommendation by the USDA; the Antibiotic Paper Packs are experimental. Published with approval of the Director, Wyoming Agricultural Experiment Station, as Journal Article 548.

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