

## The *In Vivo* Pediculicidal Efficacy of a Natural Remedy

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### Abstract

**Background:** Head louse infestations are prevalent worldwide. Over the past 20–25 years, 15–20% of all children in Israel between 4 and 13 years of age have been infested with head lice. This is mainly due to the existence of ineffective pediculicides on the market.

**Objective:** To examine the pediculicidal efficacy and safety of a natural remedy ("Chick-Chack") and to compare it in an open clinical study with a known pesticide spray.

**Methods:** The natural remedy, which contains coconut oil, anise oil and ylang ylang oil, was applied to the hair of infested children three times at 5 day intervals. Each treatment lasted for 15 minutes. The control pediculicide was a spray formulation containing permethrin, malathion, piperonyl butoxide, isododecane and propellant gas, which was applied twice for 10 minutes with a 10 day interval between applications.

**Results:** Of 940 children, aged 6–14 years, from six schools in Jerusalem who were examined for head louse infestation, 199 (21.2%) were infested with lice and eggs, while 164 (17.4%) were infested only with nits. Altogether, 119 children were randomly treated with either the natural remedy or the control product. Treatment was successful with the natural remedy in 60 children (92.3%) and with the control pediculicide in 59 children (92.2%). There were no significant side effects associated with either formulation.

**Conclusions:** The natural remedy was very effective in controlling louse infestations under clinical conditions and caused no serious side effects.

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Head lice are obligate parasites, spending their entire life on the host scalp and feeding exclusively on blood four to five times daily. Humans are the only known hosts of this parasite. Although any part of the scalp may be colonized, lice favor the nape of the neck and the area behind the ears where they mostly lay their eggs. Head lice infest a new host primarily through close contact between individuals, making child-child and parent-child interactions the more likely routes of infestation, rather than shared combs, brushes, towels, clothing and bedding. Head-to-head contact is by far the most common mode of lice transmission. Factors significantly influencing head louse infestation include: the number of children in the family, crowding, sharing of beds and closets, hair-washing habits, local customs and social contacts, healthcare in a particular area (e.g., school), and socioeconomic status [1,2]. Children between the ages of 3 and 14 are the most frequently infested [3]. Girls are more frequently infested than boys, the difference increasing with age after 4 years of age.

The most characteristic symptom of infestation is pruritus of the

head, which may begin 1–4 weeks after the initial infestation. The itch-scratch cycle can lead to secondary infection with impetigo and pyoderma. Swelling of the local lymph nodes and fever are rare. Generalized prurigo-like allergic dermatitis due to louse antigens has also been reported [4].

In order to diagnose infestation, the entire scalp should be combed thoroughly with a louse comb and the teeth of the comb should be examined for the presence of living lice after each combing. An alternative method of diagnosis is to part the hair at 2 cm intervals and look for moving lice and for eggs near the scalp. With both methods, special attention should be paid to the area near the ears and the nape of the neck. The examiner should examine the scalp for at least 5 minutes.

Over the past 20–25 years, 15–20% of all children in Israel between 4 and 13 years of age have been infested with head lice despite all efforts on the part of parents, the health and education providers, and municipalities [2,5,6]. The high prevalence of head lice is most probably due to the large number of ineffective over-the-counter pediculicides on the market and to the fact that lice have developed resistance to some pediculicides [7–9]. In September 1995 the Ministry of Health ordered that all pediculicides produced in or imported to Israel must be tested in a clinical trial in Israel to determine whether they are effective against local head lice. The aim of the present study was to determine the pediculicidal efficacy and safety of a natural remedy and to compare it in an open clinical study with a known pesticide spray.

### Subjects and Methods

#### Subjects

The study was conducted in six elementary schools in Jerusalem, where 940 children aged 6–14 years were examined for head louse infestation. These schools are designated as HO, YH, NB, DN, ER and ME. A letter was sent to the parents of all the children explaining the purpose of the study. Only those children whose parents provided written consent were examined. The percentage of children examined in each school ranged from 6.7% (ME) to 61.9% (DN).

#### Examination for lice

The hair of each child was combed first with a regular comb or brush to straighten the hair and then the entire scalp was combed with a louse comb (Innomed, Hogil, Purchase, NY, USA) for about 3–5 minutes or until the first louse was isolated. In cases where the child's hair did not allow the use of a louse comb, the scalp was

examined by hand for 5–7 min. At the end of each examination day all examined children received a letter for their parents explaining that their child has been examined and was/was not infested with lice. The parents of infested children were requested to come with their children to the school, where they signed a consent form and were given the pediculicide together with instructions for its use.

### Pediculicides tested

Chick-Chack (a colloquial Hebrew term meaning quickly) is a spray containing natural products – coconut, anise and ylang ylang (from *Cananga odorata*) oils (C.T.S. Novis Ltd., Kiryat Malakhi, Israel). It is applied to the hair three times for 15 min at intervals of 5 days. The formulation has been on the Israeli market since 1996 and is used for hair hygiene. *In vitro* studies showed that this formulation is able to eradicate 100% of lice and 68.7% of the eggs after a single 15 min application of the product (K.Y.M., unpublished results).

The control product, ParaPlus (Pharmygiene-S.C.A.T., Marseille, France), has been sold in Israel since 1997. This formulation contains 0.5% permethrin, 0.25% malathion, 2% piperonyl butoxide, 47.25% isododecane and 50% propellant gas. Infested individuals were treated twice for 10 min with a 10 day interval between treatments.

### Clinical trial

An open clinical study was conducted in which children were randomly treated with one of the two pediculicides. In all cases the parents of infested children carried out the treatment.

Every infested child who participated in the study was examined by the physician for dermatologic abnormalities such as excoriations, insect bites, lymphatic swelling, secondary infections, eczema, severe seborrheic dermatitis, as well as for conjunctivitis and other eye diseases. Only healthy children who had not been treated with an anti-lice product during the preceding 24 hours were included in the study. Criteria for exclusion of a child from the study were: severe scalp dermatosis, secondary infections, open wounds, tinea of the scalp, eye irritation (conjunctivitis) and severe eye diseases (with the exception of myopia).

Children were examined a second time 1 or 2 days after the first treatment to determine whether the pediculicide had eradicated all the active stages of the lice. The physician examined the children for treatment side effects on the skin and eyes, and recorded the child's impressions regarding the smell, itching, etc., during and after the treatment.

The treatment was considered unsuccessful if the child was found to be infested with living lice during the second parasitologic examination. The parents of those children received another pediculicide based on malathion, Prioderm shampoo (Napp, Cambridge, UK), and were requested to continue the treatment with this product.

A second examination took place 10 days after the beginning of the first treatment to determine whether the pediculicide had eliminated the entire louse population, i.e., the lice that had hatched from the eggs in the meantime. Again, the treatment was considered unsuccessful if lice were detected on the child's head.

### Statistical analysis

The rate of infestation in different schools and grades was compared using the chi-square test for association. The treatment success in different schools and grades was analyzed by using the mixed model analysis of variance. Treatment, school, and grade were assumed to be fixed effects, while class nested within grade was assumed to be a random effect.

### Results

Overall, 199 of 940 children (21.2%) were infested with living lice and eggs, while 164 (17.4%) were infested with nits only. Significant differences were seen between the schools ( $P < 0.001$ ) in lice infestation rates, but not in nit infestation rates. Children from three schools (NB, HO and ER) had the highest infestation rates (35.3%, 25.0% and 24.8%, respectively) [Table 1]. Significant differences were also seen in lice infestation rates between the grades ( $P < 0.001$ ), but not in nit infestation rates. Children from the first, second and third grades had the highest infestation rates (24.5%, 31.4% and 23.2%, respectively) [Table 2].

Of 199 louse-infested children, 143 were included in the study of whom 129 complied with the instructions for use and were randomly treated with either the natural remedy or the control product. Treatment was successful in 119 children, the success rate varying between 91.3% and 95.2% in the five schools [Table 3]. Neither the formulation used, nor the school or grade had a significant effect on the success of the treatment. There were no significant differences in efficacy between the two pediculicides.

**Table 1.** Number of children examined in six schools in Jerusalem, and percentage of those infested either with living lice and eggs or nits only

School	No. of children	No. examined (%)	Positive for lice (%)	Nits only (%)	Negative for lice (%)
HO	804	200 (24.8)	50 (25.0)	41 (20.5)	109 (54.5)
YH	401	162 (40.4)	19 (11.7)	24 (14.8)	119 (73.5)
NB	750	68 (9.1)	24 (35.3)	8 (11.8)	36 (52.9)
DN	310	192 (61.9)	35 (18.2)	27 (14.1)	130 (67.7)
ER	466	287 (61.6)	71 (24.8)	61 (21.2)	155 (54.0)
ME	460	31 (6.7)	–	3 (9.7)	28 (90.3)
Total (%)	3,191	940 (29.5)	199 (21.2)	164 (17.4)	577 (61.4)

**Table 2.** Percentage of infested children with lice and nits by class

Class	No. of children examined	No. (%) of children with lice	No. (%) of children with nits
First grade	147	36 (24.5)	29 (19.7)
Second grade	188	59 (31.4)	31 (16.5)
Third grade	151	35 (23.2)	23 (15.2)
Fourth grade	171	31 (18.1)	37 (21.6)
Fifth grade	153	26 (17.0)	25 (16.3)
Sixth grade	90	8 (8.9)	17 (18.9)
Seventh grade	11	–	1 (9.1)
Eighth grade	29	4 (13.8)	1 (3.5)

**Table 3.** Treatment success rates in five schools

School	No. included in the study	Complied	Successfully treated (%)
HO	44	40	38 (95.2)
YH	12	11	10 (91.7)
NB	24	21	19 (91.3)
DN	31	28	25 (93.1)
ER	32	29	27 (93.5)
Total (%)	143	129 (90.2)	119 (92.2)

**Table 4.** Efficacy of natural remedy and control formulation in children who were treated and complied with the instructions for use

Formulation	No. treated	Complied (%)	Successfully treated (%)
Natural remedy	70	65 (92.9)	60 (92.3)
Control product	73	64 (87.7)	59 (92.2)
Total	143	129 (90.2)	119 (92.2)

Sixty children (92.3%) were successfully treated with the natural remedy and 59 children (92.2%) with the control product [Table 4].

No clinically detectable side effects were seen in any of the children. Five children treated with the natural remedy and four children treated with the control formulation complained about the unpleasant odor of the formulations at the beginning of the treatment. One child treated with the natural remedy and another treated with the control formulation complained of pruritus in the neck area immediately after the treatment.

## Discussion

In the present study 21.2% of the children were infested with living lice and eggs, while 17.4% were infested with nits only. Infestation with nits indicated that the children had been infested with lice in the previous 6 months and had been treated successfully for lice. The above numbers concur with the data collected from over 15,000 children in Israel over the last 15 years, according to which 11–19% of children aged 4–13 were infested with living lice and eggs while 22–39% had nits only [3–5].

The most frequently infested age group was 6–9 year olds from the first three grades. This is in accordance with previous studies in Israel in which 4–17 year olds were examined and those aged 4–11 (with a peak at 9 years) were the most frequently infested [3,10].

Today, there are 10 pediculicides on the Israeli market based on organophosphates (0.4–1% malathion), carbamates (0.5 carbaryl), pyrethrins (0.33 pyrethrum) and pyrethroids (1% permethrin, 0.2% phenothrin and 0.1% bioallethrin) [11]. However, not all of them are fully effective in controlling louse infestations. Only 5 of 14 pediculicides available in Israel, tested *in vitro* in 1990, were found to be fully effective [7].

None of the existing pediculicides on the market is capable of controlling 100% of the eggs after a single application. There are several pediculicides whose instructions recommend that the treatment be repeated after 6–7 days. However, because eggs hatch 6–10 days after oviposition [12] the treatment is more

effective if it is repeated after 10 days. In order to eradicate the maximum number of lice on the head between the two treatments (days 2–9) – while the lice are hatching from the eggs – an additional treatment on day 5 is recommended.

Resistance of head lice to organochlorine insecticides such as DDT and lindane has been reported from many parts of the world including Israel, Canada, Denmark and Malaysia [13,14]. The baseline susceptibility of Israeli head louse populations to permethrin was determined in 1989, 2 years before it was made available to the public [15]. Following the first reports of control failure by permethrin in this country in 1993, a study conducted in 1994 showed a fourfold reduction of head louse susceptibility [8]. Resistance of head lice to permethrin and cross-resistance of lice to different pyrethroids has also been observed in France, Britain, the Czech Republic and the USA [16–19].

Several techniques are recommended to delay the emergence of resistance in lice. These include: rotation of insecticides (the sole use of an insecticide for 2–3 years and its replacement with another insecticide), mosaic treatment (the use of several insecticides to control a parasitic insect in a given area), and combinations of two or more insecticides within the same formulation. Since both formulations used in the present study contain at least two active ingredients, we assume that they will remain effective for long periods.

In conclusion, the natural remedy as well as the control pediculicide were both very effective in controlling louse infestations under clinical conditions and caused no serious side effects. Furthermore, Chick-Chack contains only natural ingredients, which would probably make it more acceptable to the general public.

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