UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES



MEMORANDUM

DATE: 6/29/2009

SUBJECT: **Carbaryl:** Data Evaluation Record for the Study "Determination of Dislodgeable Residues of Carbaryl from the Hair of Dogs Wearing Collars Impregnated with Carbaryl"

**PC Code:** 056801
**MRID No.:** 47739401, 47739402
**Petition No.:** NA
**Assessment Type:** NA
**TXR No.:** NA

**DP Barcode:** D364767
**Registration No.:** NA
**Regulatory Action:** Data Evaluation Record
**Reregistration Case No.:** NA
**CAS No.:** 63-25-2

FROM: Wade Britton, Industrial Hygienist
Risk Assessment Branch V
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The purpose of this document is to provide a secondary data evaluation record (DER) for the study report "Determination of Dislodgeable Residues of Carbaryl from the Hair of Dogs Wearing Collars Impregnated with Carbaryl (MRID 47739402)"submitted by Wellmark International in response to data call in (DCI) as a part of the 06/30/2003 interim risk eligibility decision (RED). This study measures the the amount of carbaryl that may be dislodged from dog's hair while the dog is wearing a Zodiac FleaTrol® Flea Collar for Dogs, a carbaryl impregnated collar. The Agency has determined that the study is acceptable for use in quantifying estimated exposure/risk. A primary review of the study was conducted by Versar Inc.

This document also includes a review of a registrant submitted human health risk assessment, "Exposure and Risk Assessment for Carbaryl Dog Collars Using Data from a Clipping Study (MRID 47739401)." The Agency has determined that the submitted risk assessment has issues which preclude its use to inform the updated human health risk assessment for the use pattern. The Agency's review is included as an appendix to the study review (Appendix B).

**STUDY TYPE:** Dislodgeable Residues in Dog Hair after Application of Impregnated Dog Collar

**TEST MATERIAL:** The test substance was an impregnated plastic collar (Zodiac FleaTrol® Flea Collar for Dogs) containing a nominal 17% (wt/wt) carbaryl as the active ingredient.

**SYNONYMS:** Wellmark International Code Name: RF75D Carbaryl Dog Collar
Common Name: Carbaryl Dog Collar

**CITATION:**

| | |
|---|---|
| Author: | Brian D. Lange |
| Title: | Determination of Dislodgeable Residues of Carbaryl From the Hair of Dogs Wearing Collars Impregnated with Carbaryl |
| Study Completion Date: | April 27, 2009 |
| Testing Facility: | Access Research and Consulting, Inc<br>4720 W. Jennifer Avenue, Suite 106<br>Fresno, CA 93722 USA |
| Identifying Codes: | Report Number: AR27130 |

**SPONSOR:** Wellmark International
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## EXECUTIVE SUMMARY:

This study measured the amount of carbaryl that may be dislodged from dog's hair while the dog is wearing a Zodiac FleaTrol® Flea Collar for Dogs, a carbaryl impregnated collar. One collar, containing 17.71% carbaryl was placed around the neck of each of ten dogs, following label instructions. The test product was formulated as a slow release product intended for 120-day use. There were two control dogs without collars. The dogs were of varying breeds. Half of the dogs had long hair and half of the dogs had medium length hair. According to the study author, the sampling technique precluded the use of short-haired dogs. The dogs had not been exposed to carbaryl for at least 30 days prior to application of the collars and were bathed with a non-pesticidal shampoo 5 days prior to the study. The dogs were housed individually and handled minimally during the study.

Hair samples were collected from five locations on each dog: neck (above the collar), middle of back, lumbar (top of tail), left thorax, and right thorax. Sampling took place on Days 0 (5 hrs), 1, 4, 7, 14, and 28 after application of the collar. Samples were also collected one day prior to application. Hair samples were collected using clippers and hair was clipped down to the skin level.

The hair samples were dislodged on the same day as collection using Aerosol OT Solution. After dislodging, the hair and the OT solution samples were stored frozen until analysis. Both OT solution samples and dislodged hair extract samples were analyzed.

Residues of carbaryl in each sample (µg) were converted to µg per $cm^2$ of skin surface area from which the sample was collected. The residues were not corrected for field fortification recoveries, concurrent recoveries, or storage stability recoveries because the field fortification recoveries were greater than 90%, recoveries from laboratory fortified recoveries were not reported, and storage stability recoveries were acceptable. For calculation purposes, ½ limit of quantitation (LOQ) values were used for residues less than the LOQ. The individual residues were calculated by the Registrant and the Agency in the same manner. Any differences could be attributed to rounding. It should be noted however, that it appears that the average residues for four of the sample locations on each sampling day were not presented by the Registrant. The differences in the averages calculated by the Agency and the Registrant are small, but are greater than can be accounted for by rounding differences. The overall average residues calculated by the Registrant matched the Agency's calculations.

The results of this study indicate that carbaryl residues spread from the impregnated collar to the neck, back, lumbar, and thorax of the dog. Carbaryl residues were detected in the majority of the dislodging OT solution samples and the dislodged hair extract samples at all sampling intervals (Day 0 through Day 28) and all sampling locations. The

carbaryl residues remained relatively constant from Day 0 through Day 28, with an exception of the neck residues in the hair extract samples which increased significantly over time and the residues were 4.9X higher on Day 28 than Day 0 based on the average of all replicates. Carbaryl residues were significantly higher in the neck region than the other regions sampled (back, lumbar, and thorax). Additionally, the other regions all showed similar levels of carbaryl. From highest to lowest, average carbaryl residues in the OT solution samples were 44.4 $\mu g/cm^2$ for the neck, 2.49 $\mu g/cm^2$ for the back, 1.20 $\mu g/cm^2$ for the lumbar and the left thorax, and 1.08 $\mu g/cm^2$ for the right thorax. The overall average for the OT solution samples was 10.1 $\mu g/cm^2$. The average carbaryl residues in the hair extract samples, from highest to lowest, were 6.10 $\mu g/cm^2$ for the neck, 0.51 $\mu g/cm^2$ for the back, 0.37 $\mu g/cm^2$ for the left and right thorax, and 0.34 $\mu g/cm^2$ for the lumbar. The overall average for the hair extract samples was 1.54 $\mu g/cm^2$.

Carbaryl residues were higher in the OT solution samples than the hair extract samples. According to the study author, the extracted hair samples may be more reflective of the solubility of carbaryl in the aqueous OT solution than the availability of carbaryl for transfer to a person handling the dog.

The Agency did not perform a regression analysis because in general, the residue pattern did not show steady increase or decrease in residues. Additionally, residues were highly variable between replicates. When calculating the average residues for each sampling location, the standard deviation values were often at a similar level or higher than the average values. Unfortunately, the data (average residues) is limited and not conducive for regression tests. Additionally, the plot of average residues vs. time follows a sinusoidal pattern which makes it very difficult to conduct a simple regression analysis. The Agency conducted linear and exponential regression analysis (using MS Excel) with the average residues as well as the raw data (all residues). In both cases, the R squared and 95% significance values (p value) were very low, which indicated that the results of the analyses were not statistically significant. The Agency also tried some transformations (natural logarithm, square, and square root) of the raw data and then repeated the regression analyses, only to get low p and R squared values once again.

Based on the information presented in the study, the following issues of concern are noted:

- The impregnated pet collar is designed to slowly release, over a 120-day period, the active ingredient in concentrations sufficient to control the target pests. The data collected during the 28-day sampling period indicates that the release/dissipation is not linear during that 28-day period. A sampling protocol that included sampling at intervals throughout the 120-day period would have provided a more accurate characterization of the chemical release and dissipation properties of the active ingredient.

- The individual residues were highly variable between dogs at each sampling interval, as indicated by large standard deviations.

- Adequate analytical data sheets and documentation was not provided:
  - No raw data sheets were provided, only a summary table with the calculated residues.
  - For the field fortification results, only percent recoveries were reported.
  - Dates of sample extraction and analysis were not provided, as well as storage duration from collection to analysis.
  - It does not appear that laboratory fortified samples were run with each analytical set, though the study protocol indicates that analytical sample sets were to include experimental samples, at least one control, duplicate fortifications, and calibration standards. The lack of raw analytical data sheets prohibited investigating this further.

- Hair samples were dislodged on the day of collection, however, the number of hours between collection and dislodging was not reported. EPA typically recommends that dislodging occur within 4 hours.

- The field fortification levels did not completely encompass the residue levels in the experimental field samples. A few of the OT solution experimental samples had residues that were half the level of the lowest field fortification, and one sample contained residue twice the magnitude of the highest field fortification level. A few of the hair extract experimental samples had residues up to 6 times higher than the highest field fortification level

protected kennel. The dogs remained in single occupancy pens throughout the study and were handled minimally.

Environmental Conditions: Environmental conditions were monitored on-site. Air temperatures ranged from 12 to 39°C. There was no rain during the study.

Diet: Not Reported

Health: The dogs selected were in good health and had no signs of skins disorders, scrapes, lesions, hair thinning, or other malady. No adverse effects were observed during the course of the study.

**Table 1. Summary of Dog Types**

| Replicate | Breed | Age (months) | Sex | Height (cm) | Length (cm) | Weight (kg) |
|---|---|---|---|---|---|---|
| Control 91 | Shepherd | 122 | M | 48 | 88 | 22 |
| Control 92 | Lab Shepherd Cross | 97 | F | 56 | 92.7 | 26.3 |
| 1 | Setter Cross | 124 | M | 51 | 88.5 | 20.5 |
| 2 | Border Collie/Heeler Cross | 124 | M | 52 | 89 | 24.9 |
| 3 | Shepherd Cross | 88 | F | 48 | 86.7 | 22 |
| 4 | Lab Cross | 85 | M | 52.2 | 92.5 | 21 |
| 5 | Collie Cross | 43 | F | 56.4 | 93 | 20.6 |
| 6 | Walker Hound | 112 | M | 49.8 | 96.4 | 28.2 |
| 7 | Lab Cross | 85 | F | 48 | 92.4 | 22.5 |
| 8 | Lab Cross | 69 | M | 52.8 | 89 | 25.9 |
| 9 | Shepherd Cross | 73 | F | 48.4 | 86.5 | 23.1 |
| 10 | Mongrel | 42 | M | 53 | 87.7 | 28 |
| Minimum | | 48.0 | N/A | 48 | 86.5 | 20.5 |
| Maximum | | 56.4 | N/A | 56.4 | 96.4 | 28.2 |
| ***Average*** | | ***51.3*** | ***N/A*** | ***51.3*** | ***90.2*** | ***23.75*** |
| Standard Deviation | | 2.98 | N/A | 2.98 | 3.10 | 2.80 |

**2. Surface(s) Monitored:**

Types of Surface(s): Dog haircoats

Hair Characteristics of Animals: Of the ten treatment dogs, five were long-haired (replicates 1-5) and five were medium-haired (replicates 6-10). According to the study author, the sampling technique precluded the use of short-haired dogs. The average hair length, based on hair samples from the neck, mid back, lumbar, right thorax, and left thorax ranged from 2.3 to 6.6 cm. For long-haired dogs only, the average hair length was 5.4 cm and for medium-haired dogs only, the average length was 3.2 cm. All dogs had medium texture hair and all but two dogs had medium density hair. Two dogs had thin density hair (replicates 5 and 9). One dog (replicate 9) had greasy hair. The characteristics of the hair for each dog are shown in Tab le 2.

| Table 2. Summary of Hair Characteristics | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Replicate | Hair Length (cm) | | | | | | Hair Texture | Hair Density | Hair Classification | Notes |
| | Neck | Mid Back | Lumbar | Thorax Right | Thorax Left | Average | | | | |
| Control 91 | 5.5 | 6.5 | 6.0 | 3.8 | 4.0 | 5.2 | Med | Med | Long | - |
| Control 92 | 4.1 | 3.7 | 3.5 | 2.5 | 2.6 | 3.3 | Med | Med | Medium | - |
| 1 | 5.0 | 4.0 | 4.0 | 6.0 | 6.0 | 5.0 | Med | Med | Long | - |
| 2 | 7.5 | 4.5 | 5.0 | 3.5 | 3.5 | 4.8 | Med | Med | Long | - |
| 3 | 5.4 | 5.0 | 5.7 | 4.5 | 4.5 | 5.0 | Med | Med | Long | - |
| 4 | 6.0 | 5.7 | 5.9 | 7.5 | 7.7 | 6.6 | Med | Med | Long | - |
| 5 | 6.8 | 6.3 | 5.6 | 4.4 | 4.2 | 5.5 | Med | Thin | Long | - |
| 6 | 4.0 | 3.5 | 3.3 | 1.5 | 2.2 | 2.9 | Med | Med | Medium | - |
| 7 | 4.2 | 2.9 | 3.8 | 2.4 | 2.4 | 3.1 | Med | Med | Medium | - |
| 8 | 3.7 | 2.4 | 2.5 | 1.5 | 1.5 | 2.3 | Med | Med | Medium | - |
| 9 | 4.7 | 4.5 | 4.4 | 2.5 | 2.7 | 3.8 | Med | Thin | Medium | Greasy Hair |
| 10 | 7.0 | 3.0 | 4.5 | 2.5 | 2.5 | 3.9 | Med | Med | Medium | - |
| **Summary of Hair Length (cm) for All Dogs (Replicates 1 – 10)** | | | | | | | | | | |
| Minimum | 3.7 | 2.4 | 2.5 | 1.5 | 1.5 | 2.3 | - | - | - | - |
| Maximum | 7.5 | 6.5 | 6.0 | 7.5 | 7.7 | 6.6 | - | - | - | - |
| ***Average*** | ***5.3*** | ***4.3*** | ***4.5*** | ***3.6*** | ***3.7*** | ***4.3*** | - | - | - | - |
| Standard Deviation | 1.3 | 1.3 | 1.1 | 1.8 | 1.8 | 1.3 | - | - | - | - |
| **Summary of Hair Length (cm) for Long Hair Dogs (Replicates 1 – 5)** | | | | | | | | | | |
| Minimum | 5.0 | 4.0 | 4.0 | 3.5 | 3.5 | 4.8 | - | - | - | - |
| Maximum | 7.5 | 6.3 | 5.9 | 7.5 | 7.7 | 6.6 | - | - | - | - |
| ***Average*** | ***6.1*** | ***5.1*** | ***5.2*** | ***5.2*** | ***5.2*** | ***5.4*** | - | - | - | - |
| Standard Deviation | 1.0 | 0.92 | 0.8 | 1.6 | 1.7 | 0.73 | - | - | - | - |
| **Summary of Hair Length (cm) for Medium Hair Dogs (Replicates 6 – 10)** | | | | | | | | | | |
| Minimum | 3.7 | 2.4 | 2.5 | 1.5 | 1.5 | 2.3 | - | - | - | - |
| Maximum | 7.0 | 4.5 | 4.5 | 2.5 | 2.7 | 3.9 | - | - | - | - |
| ***Average*** | ***4.7*** | ***3.3*** | ***3.7*** | ***2.1*** | ***2.3*** | ***3.2*** | - | - | - | - |
| Standard Deviation | 1.3 | 0.8 | 0.8 | 0.53 | 0.46 | 0.7 | - | - | - | - |

Areas treated: The test substance was applied through the use of an impregnated plastic dog collar placed around the neck of each dog.

Other products used: None. The dogs were washed with a non-pesticidal shampoo 5 days before the start of the study and were not bathed again during the study. Additionally, the dogs had not been exposed to carbaryl for at least 30 days prior to the start of the study.

**3. Physical State of Formulation as Applied :** Impregnated Plastic Dog Collar

**4. Application Rates and Regimes:**

Application Regime: The collar was first weighed and its length measured, then it was placed around the neck of the dog, secured using the attached clasp, and the excess collar removed. One to two

inches of excess collar was left on in case an adjustment was needed. The cut end was likewise weighed and measured. Collars were applied to all dogs by the same person for consistency. Table 3 summarizes the weight and length of each collar.

**Table 3. Weight of Collars**

| Replicate | Collar As In Packaging | | Excess Collar Clipped Off After Application | | Collar as Removed After StudyCompletion | |
|---|---|---|---|---|---|---|
| | Weight (g) | Length (cm) | Weight (g) | Length (cm) | Weight (g) | Length (cm) |
| Control 91 | No collar worn | | | | | |
| Control 92 | No collar worn | | | | | |
| 1 | 33.19 | 57 | 6.08 | 12 | 26.67 | 44 |
| 2 | 32.79 | 56 | 3.77 | 7 | 28.29 | 47.5 |
| 3 | 33.16 | 56.5 | 4.25 | 8 | 28.25 | 48 |
| 4 | 33.59 | 56 | 5.51 | 10 | 27.47 | 45.5 |
| 5 | 32.63 | 55.5 | 5.23 | 10 | 26.7 | 46 |
| 6 | 32.81 | 56 | 3.55 | 7 | 28.42 | 49 |
| 7 | 32.9 | 56.5 | 4.39 | 8 | 28.4 | 48 |
| 8 | 33.26 | 56.5 | 3.46 | 7 | 28.98 | 50 |
| 9 | 33.17 | 56 | 4.53 | 8.5 | 26.04 | 46.5 |
| 10 | 32.79 | 56 | 2.91 | 5.5 | 29.03 | 50.2 |
| Minimum | 32.63 | 55.5 | 2.91 | 5.5 | 26.04 | 44 |
| Maximum | 33.59 | 57 | 6.08 | 12 | 29.03 | 50.2 |
| ***Average*** | ***33.0*** | ***56.2*** | ***4.4*** | ***8.3*** | ***27.8*** | ***47.5*** |
| Standard Deviation | 0.29 | 0.42 | 1.00 | 1.90 | 1.04 | 1.99 |

**5. Sampling:**

Method and Equipment: Hair samples were collected using an Oster Brand, PowerPro Ultra, Cordless Animal Clipper with a cutting width of 4.0 cm.

Sampling Procedure: The clipping was performed in one straight pass of the clippers. Additional cuts were made from the ending point of the first cut as needed to achieve the required sample weight. Hair was clipped down to the skin level.

Other parameters:
1. Samples at each location were collected in a centripetal way from the collar.
2. Samples were collected farther from the collar at early events, moving progressively closer to the collar at subsequent events.
3. Samples were collected from two rows, right and left of the centripetal line.
4. Samples from the neck were collected such that the short hair at the top of the neck toward the head was not collected.

Surface Areas Sampled: Each hair sample was collected from a target area of approximately one square inch (6.45 $cm^2$). The actual area was a function of the width of the clippers (4.0 cm) by the length of cut needed to achieve the target minimum

sample weight of 0.5 g. The actual area sampled was measured and recorded. Sample weights were likewise collected and recorded in the data. Actual sample areas ranged from 0.4 to 42.8 $cm^2$. Actual sample weights ranged from 0.5 to 1.7 g.

Number of sampling intervals:

There were seven sampling intervals after the application, including on days 0 (5 hours after application), 1, 4, 7, 14, 21 and 28 after application. Samples were also collected from all dogs one day prior to the application.

Replicates per sampling interval:

One sample from five different areas were collected from each of the 10 treated dogs and the 2 control dogs at each sampling interval.

For each treated dog, samples were collected from the following five areas:
1. Neck zone (above the collar)
2. Middle of the back
3. Top of the tail (lumbar zone)
4. Thorax – left side
5. Thorax – right side

Figure 1 shows the five sampling locations.

The distance between the collar and the sampling area was measured on the pre-application day and on Day 28 for each replicate. The average distance was 5.6±2.26 cm for the neck sample, 20.3±3.32 cm for the back sample, 51.9±4.10 cm for the lumbar sample, 26.4±6.63 cm for the left thorax sample, and 25.8±6.25 cm for the right thorax sample. A summary of the distances is provided in Table 4 below.

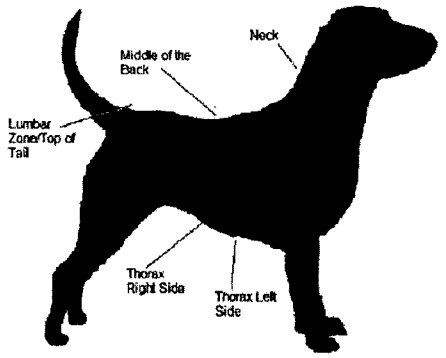


**Figure 1. Sampling Locations**

| Table 4. Distance from Collar to Clipped Area (cm) | | | | | |
|---|---|---|---|---|---|
| Statistic | Neck | Back | Lumbar | Thorax Left | Thorax Right |
| Range | 2.3 to 9.4 | 16 to 28.5 | 45.5 to 58.7 | 17.2 to 39.5 | 13.4 to 41.5 |
| Average | 5.6 | 20.3 | 51.9 | 26.4 | 25.8 |
| Standard Deviation | 2.26 | 3.32 | 4.10 | 6.63 | 6.25 |

**6. Sample Handling and Storage:**

Hair samples were place directly into labeled 250 mL glass jars with Teflon® lined lids. Samples were held and transported on substitute ice to the dislodging facility. Specimens were dislodged on the same day they were collected. After dislodging, the hair and solution samples were capped and lids secured using electrical tape. Each jar was placed into a plastic zipper bag and set at a 45 degree angle in frozen storage. Freezer storage temperatures ranged from -30 to -16°C. Sample storage temperatures were not monitored while on dry ice.

Samples were shipped by Federal Express to the analytical laboratory in ice chests (TRT and UTC in separate boxes) with dry ice on September 2, 2008, September 3, 2008, September 10, 2008, and September 24, 2008.

The duration of frozen storage (collection to analysis) was not reported.

**7. Analytical Methodologies**

Dislodging Method: Hair samples were placed into glass jars and dislodged using 50 mL of a 0.01% Aerosol OT solution, shaken on a reciprocating shaker and decanted into a second jar. The procedure was repeated for a total of 100 mL of Aerosol OT. Samples were dislodged on the same day they were collected. The solutions were filtered into LC vials for analysis.

Extraction method: The dislodged hair samples were mixed with methylene chloride. An aliquot was collected and evaporated to dryness. The sample was then reconstituted with a 1:1 methanol mixture and transferred to an LC vial for analysis.

Detection methods: A reverse-phase high performance liquid chromatographic (HPLC) method with UV diode array detection for the quantitation of the active ingredient was used. Additionally, several low level samples were analyzed by LC/MS/MS to confirm the presence of carbaryl. A summary of the typical HPLC conditions is shown in Table 5 below.

| Table 5. Summary of Typical HPLC Conditions | |
|---|---|
| Column: | Phenomenex Luna C18, 250 x 4.6 mm 5 µm particle size reverse phase column |
| Mobile Phase: | 60% Acentonitrile: 40% water with a 0.2% acetic acid in both 1 mL/min. |
| Flow Rate: | 1 mL/min |
| Injection Volume: | 50 µL |
| Detector: | UV at 263 nm |
| Column Temperature: | 40°C |

Method Validation: The analytical method was validated prior to analyzing treated study samples. Using HPLC, the average recovery of carbaryl from the dislodgeable OT solution samples was 103%±5.3% (9 samples at levels ranging from 4.84 to 2017.5 µg) and the average recovery of carbaryl from the dislodged hair extraction samples was 105%±9.0% (9 samples at levels ranging from 4.84 to 201.75 µg). Using LC/MS/MS, the average recovery of carbaryl from the dislodged hair extraction samples was 106%±5.7% (9 samples at levels ranging from 9.68 to 48.42 µg).

The limit of quantitation (LOQ) was reported to be 2 µg/sample for the OT Solution and 0.2 µg/sample for the hair extracts.

Instrument performance and calibration: An external calibration curve was established using linear regression.

Quantification: The residues were determined from the calibration curve.

**8. Quality Control:**

Lab Recovery: According to the study protocol, each analytical sample set was to include experimental samples, at least one control, duplicate fortifications, and calibration standards. However, evidence that duplicate laboratory fortified samples were prepared and analyzed with the experimental samples was not provided in the study report.

Field Fortification: Field fortification recoveries were determined in the dislodgeable solutions of dog hair and the extracted dog hair samples at 2 levels on 2 days (pre-application day and day 28). Triplicate samples were prepared and analyzed for each level. According to the Study Protocol, the fortified samples were stored frozen and shipped in the same manner as the other experimental samples.

Average recoveries in the OT solution were 99.4±4.55% at the 5.4 µg/sample level and 99.1±8.36% at the 1,020 µg/sample. Average recoveries in the extracted hair were 94.3±3.52% at the 0.48 µg/sample level and 92.1±1.70% at the 10.08 µg/sample level.

**Table 6. Summary of Field Fortification Recoveries**

| Timing | Fortification Level | Percent Recoveries | Average Percent Recovery | Standard Deviation |
|---|---|---|---|---|
| OT Solution | | | | |
| Pre-Application | Low (5.4 µg/sample) | 99, 98.2, 105 | 101 | 3.86 |
| | High (1,020 µg/sample) | 104, 105, 106 | 105 | 0.78 |
| Day 28 | Low (5.4 µg/sample) | 99.8, 102, 91.7 | 97.9 | 5.53 |
| | High (1,020 µg/sample) | 100, 94.8, 84.2 | 93.1 | 8.27 |
| Overall | Low (5.4 µg/sample) | | 99.4 | 4.55 |
| | High (1,020 µg/sample) | | 99.1 | 8.36 |
| Hair Extracts | | | | |
| Pre-Application | Low (0.48 µg/sample) | 99.2, 94.3, 92.6 | 95.3 | 3.41 |
| | High (10.08 µg/sample) | 92.8, 94.1, 90.7 | 92.5 | 1.75 |
| Day 28 | Low (0.48 µg/sample) | 88.6, 95.5, 95.6 | 93.2 | 4.00 |
| | High (10.08 µg/sample) | 90.0, 91.5, 93.8 | 91.8 | 1.92 |
| Overall | Low (0.48 µg/sample) | | 94.3 | 3.52 |
| | High (10.08 µg/sample) | | 92.1 | 1.70 |

Control Samples: Samples were collected from all dogs prior to application. Residues of carbaryl were not found above the LOQ in any of these pre-application samples. Duplicate samples were collected from the untreated dogs at each sampling interval. Very low levels of carbaryl

were detected in samples from some of the untreated control dogs. Carbaryl was detected in the Day 1 extracted hair samples (1.42 µg and 1.47 µg), but not in the corresponding OT solutions. On Day 14 carbaryl was detected above the LOQ in one OT solution sample (2.7 µg) and in one hair sample (0.27 µg). On Day 28 carbaryl was detected above the LOQ in one OT solution sample (55 µg), but not in the corresponding hair extract. The study author attributed the residues in the control samples to procedural contamination.

Storage Stability: To assess storage stability, OT solution and dog hair samples were fortified at one fortification level and analyzed on Days 0, 1, 7, 14, 21, and 28. The Day 4 through 28 samples were stored at -20°C. The Day 0 samples were analyzed immediately and the Day 1 samples were analyzed 24 hours later without being refrozen. The Study Report provided only one analytical result for each storage interval, though the Study Report stated that samples were fortified in triplicate. The recoveries for the fortified OT solution samples (201.75 µg) were 69.7% on Day 0, 100% on Day 1, 107% on Day 7, 103% on Day 14, 103% on Day 21, and 125% on Day 28. The recoveries for the fortified hair samples (20.175 µg) were 66.0% on Day 0, 83.0% on Day 1, 113% on Day 7, 103% on Day 14, 95.2% on Day 21, and 75.1% on Day 28.

## III. RESULTS

Residues of carbaryl in each sample (µg) were converted to µg per $cm^2$ of skin surface area from which the sample was collected. The residues were not corrected for field fortification recoveries, concurrent recoveries, or storage stability recoveries because the field fortification recoveries were greater than 90%, recoveries from laboratory fortified recoveries were not reported, and storage stability recoveries were acceptable. For calculation purposes, ½ LOQ values were used for residues less than the LOQ. The individual residues were calculated by the Registrant and the Agency in the same manner. Any differences could be attributed to rounding. It should be noted however, that it appears that the average residues for four of the sample locations on each sampling day were calculated incorrectly by the Registrant. The differences in the averages calculated by the Agency and the Registrant are small, but are greater than can be accounted for by rounding differences. The overall average residues calculated by the Registrant matched the Agency's calculations.

Tables 7 (OT Solution Samples) and 9 (Hair Extract Samples) provide the carbaryl residues organized by sampling day, with the raw data for each replicate (µg and µg/$cm^2$). Tables 8 (OT Solution Samples) and 10 (Hair Extract Samples) show the carbaryl residues (µg/$cm^2$ only) organized by sample location for each sampling day and includes averages calculated for all sample locations combined and all sampling days combined. All of the tables summarize the data for all replicates combined (n=10), long-haired dogs only (n=5), and medium-haired dogs only (n=5). Tables 11 and 12 provide a summary of the average values calculated by sampling location for each sampling day.

The results of this study indicate that carbaryl residues spread from the impregnated collar to the neck, back, lumbar, and thorax of the dog. Carbaryl residues were detected in the majority of the dislodging OT solution samples and the dislodged hair extract samples at all sampling intervals (Day 0 through Day 28) and all sampling locations. As shown in Figures 2 and 3, the carbaryl residues remained relatively constant from Day 0 through Day 28, with an exception of the neck residues in the hair extract samples which increased significantly over time. These residues were 4.9X higher on Day 28 than Day 0 based on the average of all replicates. Figure 4 shows the average carbaryl residue in the OT solution and hair extract samples from all sampling days combined for each sampling location separately and an average of all sampling locations. As shown in Figure 4, carbaryl residues were significantly higher in the neck region than the other regions sampled. Additionally, the other regions (back, lumbar, and thorax) all had relatively similar levels of carbaryl detected. From highest to lowest, average carbaryl residues in the OT solution samples were 44.4 µg/$cm^2$ for the neck, 2.49 µg/$cm^2$ for the back, 1.20 µg/$cm^2$ for the lumbar and the left thorax, and 1.08 µg/$cm^2$ for the right thorax. The overall average for the OT solution samples was 10.1 µg/$cm^2$. The average carbaryl residues in the hair extract samples, from highest to lowest, were 6.10 µg/$cm^2$ for the neck, 0.51 µg/$cm^2$ for the back, 0.37 µg/$cm^2$ for the left and right thorax, and 0.34 µg/$cm^2$ for the lumbar. The overall average for the hair extract samples was 1.54 µg/$cm^2$.

Carbaryl residues were higher in the OT solution samples than the hair extract samples. According to the study author, the extracted hair samples may be more reflective of the solubility of carbaryl in the aqueous OT solution than the availability of carbaryl for transfer to a person handling the dog.

The Agency did not perform a regression analysis because in general, the residue pattern did not show steady increase or decrease in residues. Additionally, residues were highly variable between replicates. When calculating the average residues for each sampling location, the standard deviation values were often at a similar level or higher than the average values. Unfortunately, the data (average residues) is limited and not conducive for regression tests. Additionally, the plot of average residues vs. time follows a sinusoidal pattern which makes it very difficult to conduct a simple regression analysis. The Agency conducted linear and exponential regression analysis (using MS Excel) with the average residues as well as the raw data (all residues). In both cases, the R squared and 95% significance values (p value) were very low, which indicated that the results of the analyses were not statistically significant. The Agency also tried some transformations (natural logarithm, square, and square root) of the raw data and then repeated the regression analyses, only to get low p and R squared values once again.

Based on the information presented in the study, the following issues of concern are noted:

- The impregnated pet collar is designed to slowly release, over a 120-day period, the active ingredient in concentrations sufficient to control the target pests. The data collected during the 28-day sampling period indicates that the release/dissipation is not linear during that 28-day period. A sampling protocol that included sampling at intervals throughout the 120-day period would have provided a more accurate characterization of the chemical release and dissipation properties of the active ingredient.

- The individual residues were highly variable between dogs at each sampling interval, as indicated by large standard deviations.

- Adequate analytical data sheets and documentation was not provided:
  - No raw data sheets were provided, only a summary table with the calculated residues.
  - For the field fortification results, only percent recoveries were reported.
  - Dates of sample extraction and analysis were not provided, as well as storage duration from collection to analysis.
  - It does not appear that laboratory fortified samples were run with each analytical set, though the study protocol indicates that analytical sample sets were to include experimental samples, at least one control, duplicate fortifications, and calibration standards. The lack of raw analytical data sheets prohibited investigating this further.

- Hair samples were dislodged on the day of collection, however, the number of hours between collection and dislodging was not reported. EPA typically recommends that dislodging occur within 4 hours.

- The field fortification levels did not completely encompass the residue levels in the experimental field samples. A few of the OT solution experimental samples had residues that were half the level of the lowest field fortification, and one sample contained residue twice the magnitude of the highest field fortification level. A few of the hair extract experimental samples had residues up to 6 times higher than the highest field fortification level.

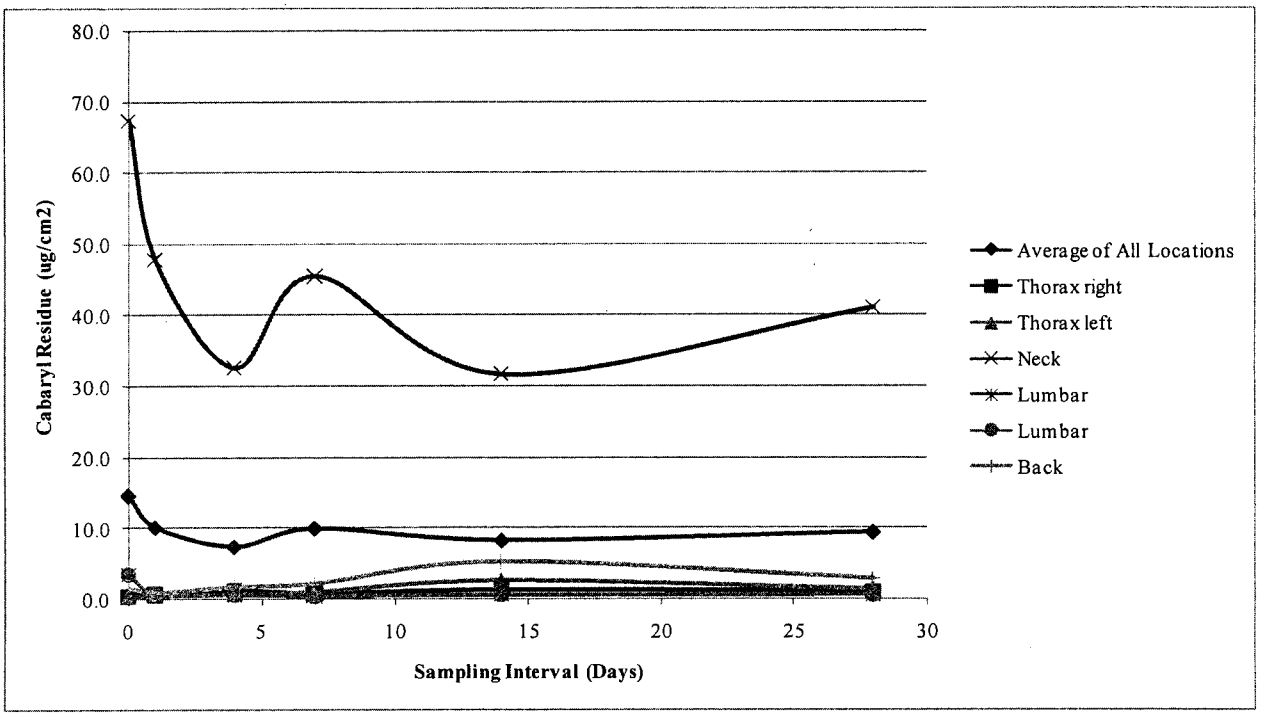


**Figure 2: Carbaryl Residue (µg/cm$^2$) versus Time (Day) for Dislodging OT Solution**

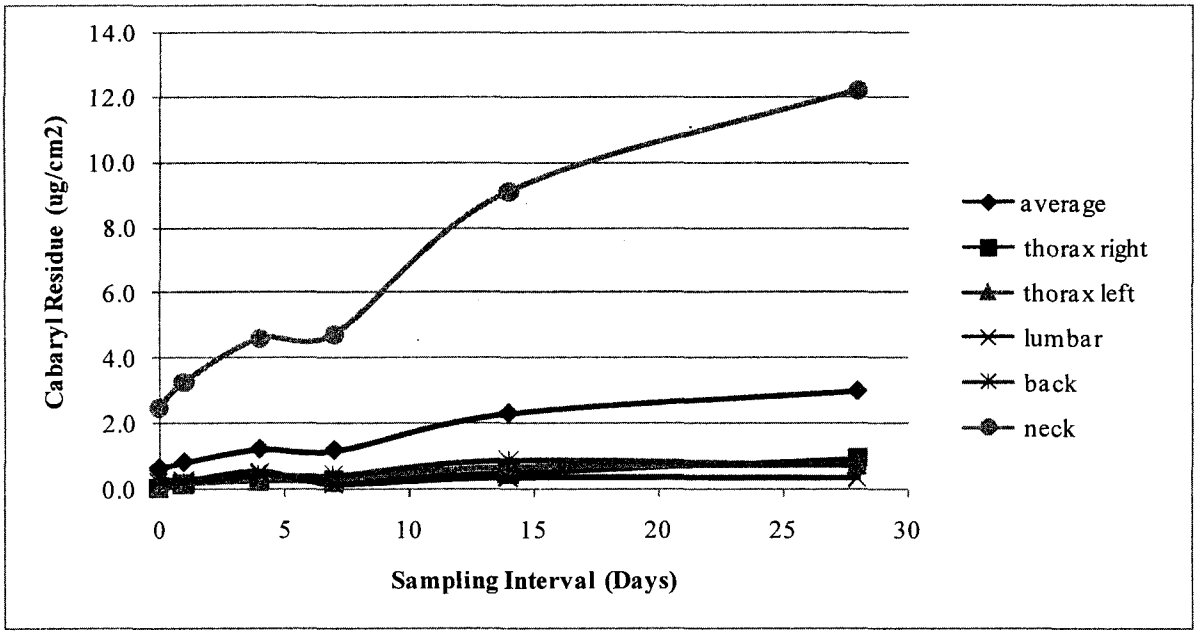


**Figure 3: Carbaryl Residue (µg/cm$^2$) versus Time (Day) for Dislodged Hair Extracts**

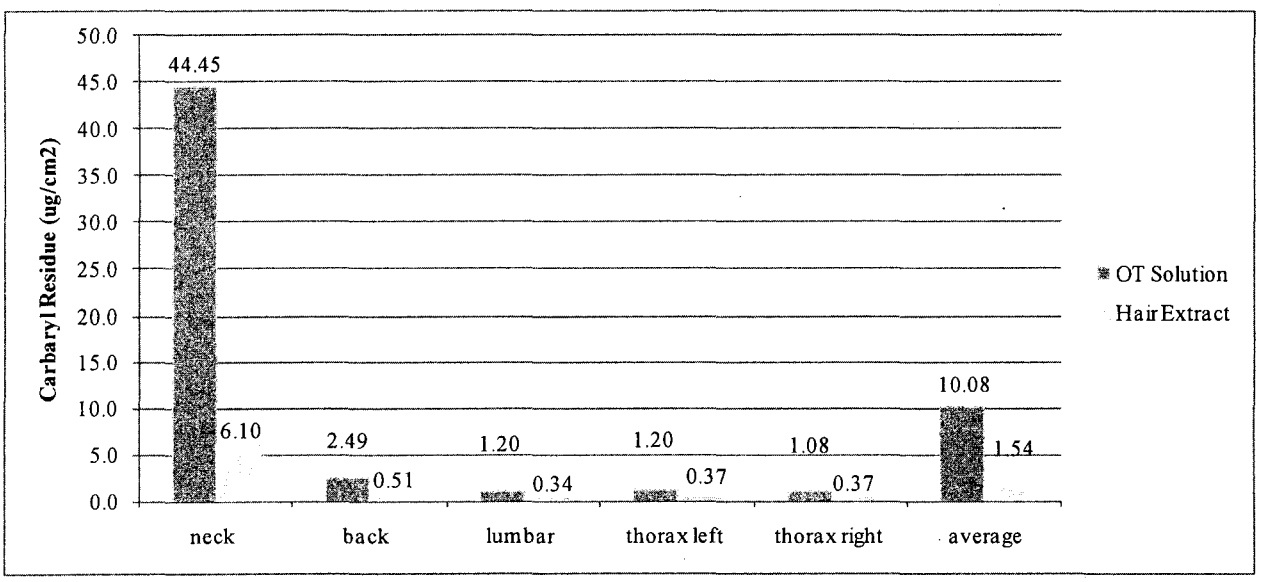


**Figure 4: Average Carbaryl Residues (µg/cm$^2$) in OT Solution and Dislodged Hair Extracts By Sampling Location (All Sampling Intervals Averaged)**

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 0 | | | | | | | | | | |
| 1 (Long) | neck | 304.6 | 75.0 | 129.5 | 22.9 | 3.6 | 84.6 | 18.0 | 37.2 | 2.8 |
| | back | 11.3 | | | | 6.4 | 1.8 | | | |
| | lumbar | 5.55 | | | | 5.2 | 1.1 | | | |
| | thorax left | 7.1 | | | | 14 | 0.51 | | | |
| | thorax right | 46.25 | | | | 23.2 | 2.0 | | | |
| 2 (Long) | neck | 316.1 | 68.7 | 138.5 | 10.0 | 0.8 | 395.1 | 80.0 | 176.1 | 2.0 |
| | back | 19.7 | | | | 7.6 | 2.6 | | | |
| | lumbar | 2.65 | | | | 1.2 | 2.2 | | | |
| | thorax left | 2.3 | | | | 20 | 0.12 | | | |
| | thorax right | 2.65 | | | | 20 | 0.13 | | | |
| 3 (Long) | neck | 24.15 | 10.1 | 7.9 | 8.5 | 0.4 | 60.4 | 14.2 | 25.9 | 3.4 |
| | back | 7.5 | | | | 1.2 | 6.3 | | | |
| | lumbar | 6.3 | | | | 2 | 3.2 | | | |
| | thorax left | 5.95 | | | | 10.4 | 0.57 | | | |
| | thorax right | 6.35 | | | | 9.2 | 0.69 | | | |
| 4 (Long) | neck | 40.9 | 16.5 | 14.8 | 11.7 | 5.2 | 7.9 | 2.4 | 3.2 | 1.1 |
| | back | 6.15 | | | | 14.8 | 0.42 | | | |
| | lumbar | 17.4 | | | | 6 | 2.9 | | | |
| | thorax left | 3.55 | | | | 14 | 0.25 | | | |
| | thorax right | 14.35 | | | | 19.6 | 0.73 | | | |
| 5 (Long) | neck | 137.45 | 31.5 | 59.2 | 9.1 | 4.8 | 28.6 | 6.4 | 12.4 | 1.0 |
| | back | 7.8 | | | | 10 | 0.78 | | | |
| | lumbar | 6 | | | | 2.4 | 2.5 | | | |
| | thorax left | 3.85 | | | | 22 | 0.18 | | | |
| | thorax right | 2.55 | | | | 27.2 | 0.09 | | | |
| 6 (Medium) | neck | 73.4 | 19.7 | 30.3 | 7.9 | 13.2 | 5.6 | 1.4 | 2.3 | 0.5 |
| | back | 4.6 | | | | 9.6 | 0.48 | | | |
| | lumbar | <LOQ | | | | 6.8 | 0.15 | | | |
| | thorax left | 12.7 | | | | 24 | 0.53 | | | |
| | thorax right | 7 | | | | 39.6 | 0.18 | | | |
| 7 (Medium) | neck | 17.85 | 22.0 | 19.2 | 15.7 | 4 | 4.5 | 6.0 | 9.5 | 2.4 |
| | back | 3.3 | | | | 2.8 | 1.2 | | | |
| | lumbar | 54.6 | | | | 2.4 | 22.8 | | | |
| | thorax left | 18.95 | | | | 22.4 | 0.85 | | | |
| | thorax right | 15.45 | | | | 20.4 | 0.76 | | | |

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 15.75 | 6.1 | 5.7 | 4.2 | 2.8 | 5.6 | 1.4 | 2.4 | 0.5 |
| | back | 5.95 | | | | 6.8 | 0.88 | | | |
| | lumbar | <LOQ | | | | 6 | 0.17 | | | |
| | thorax left | 3 | | | | 16.8 | 0.18 | | | |
| | thorax right | 4.65 | | | | 22.8 | 0.20 | | | |
| 9 (Medium) | neck | 10.5 | 5.3 | 3.2 | 4.6 | 4 | 2.6 | 0.8 | 1.0 | 0.5 |
| | back | 6 | | | | 8 | 0.75 | | | |
| | lumbar | 4.8 | | | | 8 | 0.60 | | | |
| | thorax left | 3.05 | | | | 22 | 0.14 | | | |
| | thorax right | 2.3 | | | | 20 | 0.12 | | | |
| 10 (Medium) | neck | 285.8 | 64.3 | 123.8 | 17.1 | 3.6 | 79.4 | 16.5 | 35.2 | 1.7 |
| | back | 9.45 | | | | 7.6 | 1.2 | | | |
| | lumbar | 4.9 | | | | 6.4 | 0.77 | | | |
| | thorax left | 9 | | | | 18 | 0.50 | | | |
| | thorax right | 12.4 | | | | 30 | 0.41 | | | |
| All (Reps. 1 – 10) | neck | 122.7 | 31.9 | 50.8 | 15.3 | 4.2 | 67.4 | 14.7 | 29.5 | 2.4 |
| | back | 8.2 | | | | 7.5 | 1.6 | | | |
| | lumbar | 10.4 | | | | 4.6 | 3.6 | | | |
| | thorax left | 6.9 | | | | 18.4 | 0.38 | | | |
| | thorax right | 11.4 | | | | 23.2 | 0.53 | | | |
| Long (Reps. 1 – 5) | neck | 164.6 | 40.3 | 69.6 | 15.4 | 3.0 | 115.3 | 24.2 | 50.9 | 2.7 |
| | back | 10.5 | | | | 8.0 | 2.4 | | | |
| | lumbar | 7.6 | | | | 3.4 | 2.4 | | | |
| | thorax left | 4.6 | | | | 16.1 | 0.32 | | | |
| | thorax right | 14.4 | | | | 19.8 | 0.73 | | | |
| Medium (Reps. 6 – 10) | neck | 80.7 | 23.5 | 32.1 | 13.7 | 5.5 | 19.5 | 5.2 | 8.2 | 1.7 |
| | back | 5.9 | | | | 7.0 | 0.91 | | | |
| | lumbar | 13.3 | | | | 5.9 | 4.9 | | | |
| | thorax left | 9.3 | | | | 20.6 | 0.44 | | | |
| | thorax right | 8.4 | | | | 26.6 | 0.33 | | | |

| Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 1 | | | | | | | | | | |
| 1 (Long) | neck | 937.15 | 211.1 | 407.7 | 26.5 | 7.6 | 123.3 | 26.0 | 54.4 | 2.1 |
| | back | 3.7 | | | | 12.8 | 0.29 | | | |
| | lumbar | 2.35 | | | | 10.8 | 0.22 | | | |
| | thorax left | 16.9 | | | | 15.6 | 1.1 | | | |
| | thorax right | 95.6 | | | | 19.2 | 5.0 | | | |
| 2 (Long) | neck | 605.2 | 126.7 | 267.5 | 16.7 | 5.6 | 108.1 | 22.1 | 48.1 | 1.4 |
| | back | 10.55 | | | | 8.8 | 1.2 | | | |
| | lumbar | 4.75 | | | | 10 | 0.48 | | | |
| | thorax left | 5.95 | | | | 20 | 0.30 | | | |
| | thorax right | 7.15 | | | | 25.6 | 0.28 | | | |
| 3 (Long) | neck | 32.6 | 16.5 | 11.0 | 13.5 | 2.4 | 13.6 | 4.0 | 5.4 | 2.2 |
| | back | 18.2 | | | | 6 | 3.0 | | | |
| | lumbar | 6.1 | | | | 3.6 | 1.7 | | | |
| | thorax left | 6.3 | | | | 12 | 0.53 | | | |
| | thorax right | 19.5 | | | | 14 | 1.4 | | | |
| 4 (Long) | neck | 63.85 | 18.2 | 25.6 | 10.4 | 7.2 | 8.9 | 2.1 | 3.8 | 0.8 |
| | back | 8 | | | | 12.8 | 0.63 | | | |
| | lumbar | 5.25 | | | | 10 | 0.53 | | | |
| | thorax left | 4.8 | | | | 18 | 0.27 | | | |
| | thorax right | 9.25 | | | | 20.4 | 0.45 | | | |
| 5 (Long) | neck | 307.85 | 67.2 | 134.6 | 14.4 | 7.6 | 40.5 | 8.7 | 17.8 | 1.3 |
| | back | 3.9 | | | | 8.4 | 0.46 | | | |
| | lumbar | 7.25 | | | | 3.6 | 2.0 | | | |
| | thorax left | 9 | | | | 29.2 | 0.31 | | | |
| | thorax right | 7.9 | | | | 23.6 | 0.33 | | | |
| 6 (Medium) | neck | 714.35 | 151.4 | 314.7 | 23.6 | 20 | 35.7 | 7.7 | 15.7 | 1.4 |
| | back | 8.9 | | | | 8.4 | 1.1 | | | |
| | lumbar | 6.5 | | | | 10.4 | 0.63 | | | |
| | thorax left | 15.9 | | | | 26 | 0.61 | | | |
| | thorax right | 11.25 | | | | 28.4 | 0.4 | | | |
| 7 (Medium) | neck | 52.95 | 19.3 | 19.1 | 14.3 | 6.8 | 7.8 | 2.3 | 3.1 | 1.3 |
| | back | 5.55 | | | | 6 | 0.93 | | | |
| | lumbar | 12.5 | | | | 9.2 | 1.4 | | | |
| | thorax left | 11.8 | | | | 21.2 | 0.56 | | | |
| | thorax right | 13.8 | | | | 21.6 | 0.64 | | | |

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 22.9 | 10.7 | 7.1 | 9.2 | 6 | 3.8 | 1.2 | 1.5 | 0.7 |
| | back | 8.25 | | | | 8 | 1.0 | | | |
| | lumbar | 4.45 | | | | 13.2 | 0.34 | | | |
| | thorax left | 10.15 | | | | 18.8 | 0.54 | | | |
| | thorax right | 7.7 | | | | 24 | 0.32 | | | |
| 9 (Medium) | neck | 37.85 | 15.0 | 13.2 | 11.6 | 4.4 | 8.6 | 2.1 | 3.6 | 0.9 |
| | back | 8.15 | | | | 16 | 0.51 | | | |
| | lumbar | 4.75 | | | | 10 | 0.48 | | | |
| | thorax left | 10.7 | | | | 18.8 | 0.57 | | | |
| | thorax right | 13.45 | | | | 22.8 | 0.59 | | | |
| 10 (Medium) | neck | 617.45 | 134.1 | 270.3 | 27.6 | 4.8 | 128.6 | 26.3 | 57.2 | 2.0 |
| | back | 8.6 | | | | 8.8 | 1.0 | | | |
| | lumbar | 11.2 | | | | 14 | 0.80 | | | |
| | thorax left | 17.5 | | | | 23.6 | 0.74 | | | |
| | thorax right | 15.5 | | | | 32 | 0.48 | | | |
| All (Reps. 1 – 10) | neck | 339.2 | 77.0 | 146.7 | 21.0 | 7.2 | 47.9 | 10.3 | 21.0 | 1.9 |
| | back | 8.4 | | | | 9.6 | 1.0 | | | |
| | lumbar | 6.5 | | | | 9.5 | 0.85 | | | |
| | thorax left | 10.9 | | | | 20.3 | 0.55 | | | |
| | thorax right | 20.1 | | | | 23.2 | 1.0 | | | |
| Long (Reps. 1 – 5) | neck | 389.3 | 88.0 | 168.7 | 21.2 | 6.1 | 58.9 | 12.6 | 25.9 | 2.2 |
| | back | 8.9 | | | | 9.8 | 1.1 | | | |
| | lumbar | 5.1 | | | | 7.6 | 1.0 | | | |
| | thorax left | 8.6 | | | | 19.0 | 0.50 | | | |
| | thorax right | 27.9 | | | | 20.6 | 1.5 | | | |
| Medium (Reps. 6 – 10) | neck | 289.1 | 66.1 | 124.7 | 19.7 | 8.4 | 36.9 | 7.9 | 16.2 | 1.5 |
| | back | 7.9 | | | | 9.4 | 0.90 | | | |
| | lumbar | 7.9 | | | | 11.4 | 0.72 | | | |
| | thorax left | 13.2 | | | | 21.7 | 0.60 | | | |
| | thorax right | 12.3 | | | | 25.8 | 0.49 | | | |

| Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 4 | | | | | | | | | | |
| 1 (Long) | neck | 126.65 | 31.8 | 53.1 | 13.4 | 4 | 31.7 | 6.7 | 13.9 | 1.2 |
| | back | 5.95 | | | | 10 | 0.60 | | | |
| | lumbar | 6.1 | | | | 11.6 | 0.53 | | | |
| | thorax left | 7.2 | | | | 14.8 | 0.49 | | | |
| | thorax right | 12.95 | | | | 29.6 | 0.44 | | | |
| 2 (Long) | neck | 159.65 | 42.3 | 66.2 | 18.5 | 8.4 | 19.0 | 4.8 | 8.1 | 1.4 |
| | back | 28 | | | | 8.4 | 3.3 | | | |
| | lumbar | 7 | | | | 8.8 | 0.80 | | | |
| | thorax left | 8.15 | | | | 22 | 0.37 | | | |
| | thorax right | 8.5 | | | | 26.8 | 0.32 | | | |
| 3 (Long) | neck | 52.75 | 21.1 | 18.0 | 17.0 | 4 | 13.2 | 3.8 | 5.3 | 2.1 |
| | back | 12.75 | | | | 4.8 | 2.7 | | | |
| | lumbar | 11 | | | | 8 | 1.4 | | | |
| | thorax left | 10.15 | | | | 16 | 0.63 | | | |
| | thorax right | 18.75 | | | | 15.6 | 1.2 | | | |
| 4 (Long) | neck | 56.1 | 25.8 | 20.6 | 20.0 | 5.2 | 10.8 | 3.1 | 4.4 | 1.6 |
| | back | 38.3 | | | | 15.6 | 2.5 | | | |
| | lumbar | 9 | | | | 9.6 | 0.94 | | | |
| | thorax left | 11.3 | | | | 22.8 | 0.50 | | | |
| | thorax right | 14.5 | | | | 18.8 | 0.77 | | | |
| 5 (Long) | neck | 70.45 | 21.9 | 27.5 | 13.6 | 6.4 | 11.0 | 2.8 | 4.6 | 1.1 |
| | back | 7.95 | | | | 8.8 | 0.90 | | | |
| | lumbar | 7.85 | | | | 9.2 | 0.85 | | | |
| | thorax left | 17.1 | | | | 18.8 | 0.91 | | | |
| | thorax right | 6.3 | | | | 31.2 | 0.20 | | | |
| 6 (Medium) | neck | 72.4 | 27.9 | 26.5 | 18.6 | 10.4 | 7.0 | 2.1 | 2.8 | 1.1 |
| | back | 14 | | | | 8 | 1.8 | | | |
| | lumbar | 3.65 | | | | 12.4 | 0.29 | | | |
| | thorax left | 27.8 | | | | 32.4 | 0.86 | | | |
| | thorax right | 21.65 | | | | 35.2 | 0.62 | | | |
| 7 (Medium) | neck | 54.25 | 20.8 | 20.3 | 13.5 | 4.8 | 11.3 | 2.9 | 4.7 | 1.2 |
| | back | 9.65 | | | | 9.6 | 1.0 | | | |
| | lumbar | 2.6 | | | | 8 | 0.33 | | | |
| | thorax left | 24.45 | | | | 21.6 | 1.1 | | | |
| | thorax right | 13.25 | | | | 24.8 | 0.53 | | | |

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 257.5 | 63.8 | 108.5 | 25.1 | 3.6 | 71.5 | 15.3 | 31.5 | 2.3 |
| | back | 23.45 | | | | 9.6 | 2.4 | | | |
| | lumbar | 11.05 | | | | 11.2 | 1.0 | | | |
| | thorax left | 19.35 | | | | 19.2 | 1.0 | | | |
| | thorax right | 7.65 | | | | 22.4 | 0.3 | | | |
| 9 (Medium) | neck | 383.85 | 121.6 | 162.4 | 41.4 | 5.6 | 68.5 | 16.2 | 29.5 | 3.5 |
| | back | 21 | | | | 11.2 | 1.9 | | | |
| | lumbar | 3.7 | | | | 8.4 | 0.44 | | | |
| | thorax left | 23.2 | | | | 21.2 | 1.1 | | | |
| | thorax right | 176.4 | | | | 20 | 8.8 | | | |
| 10 (Medium) | neck | 701.45 | 153.5 | 306.5 | 30.1 | 8.4 | 83.5 | 17.4 | 37.0 | 2.0 |
| | back | 10.55 | | | | 11.2 | 0.94 | | | |
| | lumbar | 6.6 | | | | 9.6 | 0.69 | | | |
| | thorax left | 33.75 | | | | 26 | 1.3 | | | |
| | thorax right | 15.05 | | | | 32.8 | 0.46 | | | |
| All (Reps. 1 – 10) | neck | 193.5 | 53.1 | 78.9 | 26.2 | 6.1 | 32.7 | 7.5 | 14.1 | 2.2 |
| | back | 17.2 | | | | 9.7 | 1.8 | | | |
| | lumbar | 6.9 | | | | 9.7 | 0.72 | | | |
| | thorax left | 18.2 | | | | 21.5 | 0.83 | | | |
| | thorax right | 29.5 | | | | 25.7 | 1.4 | | | |
| Long (Reps. 1 – 5) | neck | 93.1 | 28.6 | 36.3 | 18.0 | 5.6 | 17.1 | 4.2 | 7.2 | 1.6 |
| | back | 18.6 | | | | 9.5 | 2.0 | | | |
| | lumbar | 8.2 | | | | 9.4 | 0.90 | | | |
| | thorax left | 10.8 | | | | 18.9 | 0.58 | | | |
| | thorax right | 12.2 | | | | 24.4 | 0.59 | | | |
| Medium (Reps. 6 – 10) | neck | 293.9 | 77.5 | 121.9 | 31.4 | 6.6 | 48.4 | 10.8 | 21.0 | 2.5 |
| | back | 15.7 | | | | 9.9 | 1.6 | | | |
| | lumbar | 5.5 | | | | 9.9 | 0.55 | | | |
| | thorax left | 25.7 | | | | 24.1 | 1.1 | | | |
| | thorax right | 46.8 | | | | 27.0 | 2.2 | | | |

| Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 7 | | | | | | | | | | |
| 1 (Long) | neck | 132.4 | 28.9 | 57.9 | 5.0 | 7.2 | 18.4 | 3.8 | 8.1 | 0.5 |
| | back | <LOQ | | | | 8 | 0.13 | | | |
| | lumbar | <LOQ | | | | 7.6 | 0.13 | | | |
| | thorax left | 3.95 | | | | 16 | 0.25 | | | |
| | thorax right | 5.95 | | | | 17.6 | 0.34 | | | |
| 2 (Long) | neck | 65.7 | 18.1 | 26.9 | 8.4 | 8.4 | 7.8 | 1.9 | 3.3 | 0.6 |
| | back | 13.1 | | | | 14 | 0.94 | | | |
| | lumbar | 2 | | | | 6.4 | 0.31 | | | |
| | thorax left | 4.5 | | | | 22 | 0.20 | | | |
| | thorax right | 5.35 | | | | 27.6 | 0.19 | | | |
| 3 (Long) | neck | 82 | 25.1 | 32.2 | 14.1 | 4.4 | 18.6 | 4.7 | 7.8 | 1.7 |
| | back | 17.25 | | | | 6 | 2.9 | | | |
| | lumbar | 2.9 | | | | 7.2 | 0.40 | | | |
| | thorax left | 10.3 | | | | 14 | 0.74 | | | |
| | thorax right | 13.05 | | | | 13.6 | 1.0 | | | |
| 4 (Long) | neck | 48.9 | 15.2 | 19.3 | 7.7 | 4.8 | 10.2 | 2.4 | 4.4 | 0.6 |
| | back | 12.5 | | | | 14.4 | 0.87 | | | |
| | lumbar | <LOQ | | | | 8 | 0.13 | | | |
| | thorax left | 8.1 | | | | 22 | 0.37 | | | |
| | thorax right | 5.55 | | | | 26.4 | 0.21 | | | |
| 5 (Long) | neck | 363.75 | 82.6 | 157.2 | 23.3 | 8.4 | 43.3 | 9.4 | 19.0 | 1.7 |
| | back | 15.1 | | | | 9.2 | 1.6 | | | |
| | lumbar | 7.15 | | | | 6.4 | 1.1 | | | |
| | thorax left | 16.35 | | | | 32.8 | 0.50 | | | |
| | thorax right | 10.6 | | | | 28 | 0.38 | | | |
| 6 (Medium) | neck | 82.5 | 27.7 | 31.4 | 17.6 | 12 | 6.9 | 2.0 | 2.8 | 1.1 |
| | back | 18.4 | | | | 14 | 1.3 | | | |
| | lumbar | 5 | | | | 10.4 | 0.48 | | | |
| | thorax left | 22.55 | | | | 26.8 | 0.84 | | | |
| | thorax right | 10 | | | | 28 | 0.36 | | | |
| 7 (Medium) | neck | 94.3 | 30.0 | 36.6 | 17.8 | 6 | 15.7 | 3.8 | 6.7 | 1.4 |
| | back | 15.75 | | | | 10.8 | 1.5 | | | |
| | lumbar | 3.95 | | | | 10.8 | 0.37 | | | |
| | thorax left | 22.9 | | | | 26.8 | 0.85 | | | |
| | thorax right | 13.2 | | | | 20.4 | 0.65 | | | |

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 136.3 | 37.0 | 55.8 | 18.1 | 6 | 22.7 | 5.4 | 9.7 | 1.4 |
| | back | 19.7 | | | | 8.8 | 2.2 | | | |
| | lumbar | 14.95 | | | | 12 | 1.2 | | | |
| | thorax left | 8.4 | | | | 22 | 0.38 | | | |
| | thorax right | 5.8 | | | | 26 | 0.22 | | | |
| 9 (Medium) | neck | 545.5 | 159.2 | 219.2 | 73.4 | 5.6 | 97.4 | 23.7 | 41.3 | 7.4 |
| | back | 45.8 | | | | 4.8 | 9.5 | | | |
| | lumbar | 8.95 | | | | 10.8 | 0.83 | | | |
| | thorax left | 96.15 | | | | 16.8 | 5.7 | | | |
| | thorax right | 99.4 | | | | 19.2 | 5.2 | | | |
| 10 (Medium) | neck | 1803.15 | 376.5 | 797.6 | 43.1 | 8.4 | 214.7 | 43.8 | 95.5 | 2.8 |
| | back | 13.35 | | | | 8.8 | 1.5 | | | |
| | lumbar | 7.3 | | | | 11.6 | 0.63 | | | |
| | thorax left | 32.55 | | | | 22 | 1.5 | | | |
| | thorax right | 26 | | | | 42.8 | 0.61 | | | |
| All (Reps. 1 – 10) | neck | 335.5 | 80.0 | 142.9 | 26.8 | 7.1 | 45.6 | 10.1 | 19.8 | 2.3 |
| | back | 17.2 | | | | 9.9 | 2.3 | | | |
| | lumbar | 5.4 | | | | 9.1 | 0.56 | | | |
| | thorax left | 22.6 | | | | 22.1 | 1.1 | | | |
| | thorax right | 19.5 | | | | 25.0 | 0.91 | | | |
| Long (Reps. 1 – 5) | neck | 138.6 | 34.0 | 58.5 | 12.6 | 6.6 | 19.7 | 4.4 | 8.5 | 1.1 |
| | back | 11.8 | | | | 10.3 | 1.3 | | | |
| | lumbar | 2.8 | | | | 7.1 | 0.42 | | | |
| | thorax left | 8.6 | | | | 21.4 | 0.41 | | | |
| | thorax right | 8.1 | | | | 22.6 | 0.42 | | | |
| Medium (Reps. 6 – 10) | neck | 532.4 | 126.1 | 227.4 | 40.5 | 7.6 | 71.5 | 15.7 | 31.2 | 3.4 |
| | back | 22.6 | | | | 9.4 | 3.2 | | | |
| | lumbar | 8.0 | | | | 11.1 | 0.71 | | | |
| | thorax left | 36.5 | | | | 22.9 | 1.9 | | | |
| | thorax right | 30.9 | | | | 27.3 | 1.4 | | | |

| Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 14 | | | | | | | | | | |
| 1 (Long) | neck | 203.7 | 45.7 | 88.4 | 9.8 | 4.8 | 42.4 | 8.8 | 18.8 | 0.8 |
| | back | 5.37 | | | | 12.4 | 0.43 | | | |
| | lumbar | <LOQ | | | | 8.4 | 0.12 | | | |
| | thorax left | 8.25 | | | | 21.2 | 0.39 | | | |
| | thorax right | 10.1 | | | | 22.8 | 0.44 | | | |
| 2 (Long) | neck | 79.6 | 19.5 | 33.7 | 6.8 | 6.8 | 11.7 | 2.7 | 5.1 | 0.6 |
| | back | 9.4 | | | | 8.4 | 1.1 | | | |
| | lumbar | 2.09 | | | | 6.8 | 0.31 | | | |
| | thorax left | 3.31 | | | | 18 | 0.18 | | | |
| | thorax right | 2.89 | | | | 21.6 | 0.13 | | | |
| 3 (Long) | neck | 88.7 | 33.3 | 35.1 | 19.2 | 3.2 | 27.7 | 7.6 | 11.6 | 2.6 |
| | back | 46.73 | | | | 6 | 7.8 | | | |
| | lumbar | 3.44 | | | | 7.6 | 0.45 | | | |
| | thorax left | 10.7 | | | | 12 | 0.89 | | | |
| | thorax right | 17 | | | | 13.2 | 1.3 | | | |
| 4 (Long) | neck | 70.4 | 19.0 | 29.1 | 7.5 | 8.8 | 8.0 | 1.9 | 3.4 | 0.5 |
| | back | 4.72 | | | | 10.4 | 0.45 | | | |
| | lumbar | <LOQ | | | | 9.2 | 0.11 | | | |
| | thorax left | 13.25 | | | | 24 | 0.55 | | | |
| | thorax right | 5.46 | | | | 28 | 0.20 | | | |
| 5 (Long) | neck | 155.31 | 40.3 | 64.6 | 16.5 | 8.8 | 17.6 | 4.1 | 7.6 | 1.2 |
| | back | 12.36 | | | | 10 | 1.2 | | | |
| | lumbar | 3.02 | | | | 6.4 | 0.47 | | | |
| | thorax left | 20.65 | | | | 24.4 | 0.85 | | | |
| | thorax right | 10.16 | | | | 30.8 | 0.33 | | | |
| 6 (Medium) | neck | 98.47 | 30.2 | 38.9 | 16.9 | 16 | 6.2 | 1.8 | 2.4 | 1.1 |
| | back | 8.03 | | | | 10 | 0.80 | | | |
| | lumbar | 4.35 | | | | 12 | 0.36 | | | |
| | thorax left | 23.52 | | | | 25.2 | 0.93 | | | |
| | thorax right | 16.83 | | | | 18 | 0.94 | | | |
| 7 (Medium) | neck | 78.69 | 28.9 | 28.6 | 21.2 | 8 | 9.8 | 3.0 | 3.8 | 1.9 |
| | back | 11.05 | | | | 7.2 | 1.5 | | | |
| | lumbar | 11.3 | | | | 7.2 | 1.6 | | | |
| | thorax left | 27.3 | | | | 22.4 | 1.2 | | | |
| | thorax right | 15.91 | | | | 20.8 | 0.76 | | | |

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 73.65 | 22.3 | 29.4 | 11.9 | 5.2 | 14.2 | 3.4 | 6.0 | 1.0 |
| | back | 20.31 | | | | 10 | 2.0 | | | |
| | lumbar | 3.23 | | | | 10 | 0.32 | | | |
| | thorax left | 8.79 | | | | 18.8 | 0.47 | | | |
| | thorax right | 5.59 | | | | 24.8 | 0.23 | | | |
| 9 (Medium) | neck | 407.56 | 242.9 | 176.1 | 152.0 | 6.8 | 59.9 | 25.4 | 23.3 | 15.0 |
| | back | 425.09 | | | | 11.6 | 36.6 | | | |
| | lumbar | 14.95 | | | | 7.6 | 2.0 | | | |
| | thorax left | 232.01 | | | | 12 | 19.3 | | | |
| | thorax right | 134.8 | | | | 14.8 | 9.1 | | | |
| 10 (Medium) | neck | 723.89 | 161.1 | 314.7 | 39.3 | 6 | 120.6 | 25.2 | 53.4 | 2.9 |
| | back | 11.59 | | | | 12.4 | 0.93 | | | |
| | lumbar | 18.37 | | | | 16 | 1.1 | | | |
| | thorax left | 33.54 | | | | 12.8 | 2.6 | | | |
| | thorax right | 18.24 | | | | 30.4 | 0.60 | | | |
| All (Reps. 1 – 10) | neck | 198.0 | 64.3 | 76.9 | 36.2 | 7.4 | 31.8 | 8.4 | 13.2 | 3.4 |
| | back | 55.5 | | | | 9.8 | 5.3 | | | |
| | lumbar | 6.3 | | | | 9.1 | 0.68 | | | |
| | thorax left | 38.1 | | | | 19.1 | 2.7 | | | |
| | thorax right | 23.7 | | | | 22.5 | 1.4 | | | |
| Long (Reps. 1 – 5) | neck | 119.5 | 31.5 | 49.4 | 13.2 | 6.5 | 21.5 | 5.0 | 9.3 | 1.3 |
| | back | 15.7 | | | | 9.4 | 2.2 | | | |
| | lumbar | 2.1 | | | | 7.7 | 0.29 | | | |
| | thorax left | 11.2 | | | | 19.9 | 0.57 | | | |
| | thorax right | 9.1 | | | | 23.3 | 0.48 | | | |
| Medium (Reps. 6 – 10) | neck | 276.5 | 97.1 | 105.1 | 58.5 | 8.4 | 42.1 | 11.8 | 17.2 | 5.3 |
| | back | 95.2 | | | | 10.2 | 8.4 | | | |
| | lumbar | 10.4 | | | | 10.6 | 1.1 | | | |
| | thorax left | 65.0 | | | | 18.2 | 4.9 | | | |
| | thorax right | 38.3 | | | | 21.8 | 2.3 | | | |

**Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 28 | | | | | | | | | | |
| 1 (Long) | neck | 576.3 | 119.2 | 255.6 | 8.5 | 4 | 144.1 | 29.1 | 64.3 | 0.8 |
| | back | <LOQ | | | | 10 | 0.10 | | | |
| | lumbar | <LOQ | | | | 10.4 | 0.10 | | | |
| | thorax left | 8.4 | | | | 16.8 | 0.50 | | | |
| | thorax right | 9.2 | | | | 14.8 | 0.62 | | | |
| 2 (Long) | neck | 100.15 | 21.3 | 44.1 | 3.2 | 4.4 | 22.8 | 4.7 | 10.1 | 0.4 |
| | back | 3.35 | | | | 7.6 | 0.44 | | | |
| | lumbar | <LOQ | | | | 9.2 | 0.11 | | | |
| | thorax left | <LOQ | | | | 11.6 | 0.086 | | | |
| | thorax right | <LOQ | | | | 12.8 | 0.078 | | | |
| 3 (Long) | neck | 86.4 | 21.3 | 36.5 | 7.3 | 6 | 14.4 | 3.4 | 6.2 | 1.0 |
| | back | 5.15 | | | | 3.6 | 1.4 | | | |
| | lumbar | <LOQ | | | | 6.8 | 0.15 | | | |
| | thorax left | 7.35 | | | | 11.6 | 0.63 | | | |
| | thorax right | 6.45 | | | | 14.8 | 0.44 | | | |
| 4 (Long) | neck | 45.65 | 12.7 | 18.6 | 5.8 | 3.2 | 14.3 | 3.2 | 6.2 | 0.7 |
| | back | 3.35 | | | | 3.6 | 0.93 | | | |
| | lumbar | <LOQ | | | | 8.4 | 0.12 | | | |
| | thorax left | 5.1 | | | | 22 | 0.23 | | | |
| | thorax right | 8.55 | | | | 22 | 0.39 | | | |
| 5 (Long) | neck | 112.1 | 29.8 | 46.4 | 12.8 | 6 | 18.7 | 4.3 | 8.0 | 1.3 |
| | back | 5.7 | | | | 14.8 | 0.39 | | | |
| | lumbar | 3.4 | | | | 4.4 | 0.77 | | | |
| | thorax left | 19.45 | | | | 14 | 1.4 | | | |
| | thorax right | 8.1 | | | | 18.8 | 0.43 | | | |
| 6 (Medium) | neck | 119.3 | 30.8 | 49.7 | 13.0 | 7.2 | 16.6 | 3.8 | 7.1 | 1.2 |
| | back | 5.7 | | | | 10 | 0.57 | | | |
| | lumbar | 3.5 | | | | 6.8 | 0.51 | | | |
| | thorax left | 14 | | | | 18 | 0.78 | | | |
| | thorax right | 11.35 | | | | 14.4 | 0.79 | | | |
| 7 (Medium) | neck | 337.85 | 77.8 | 145.6 | 20.2 | 6.8 | 49.7 | 10.9 | 21.7 | 2.3 |
| | back | 8 | | | | 8.8 | 0.91 | | | |
| | lumbar | 3.35 | | | | 7.2 | 0.47 | | | |
| | thorax left | 24.8 | | | | 12.8 | 1.9 | | | |
| | thorax right | 15 | | | | 9.6 | 1.6 | | | |

| Table 7. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Replicate | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) of All Parts Combined | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg $cm^2$) of All Parts Combined[8] | | |
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 57.45 | 18.8 | 21.8 | 12.8 | 6 | 9.6 | 2.6 | 3.9 | 1.3 |
| | back | 13.8 | | | | 7.2 | 1.9 | | | |
| | lumbar | 7.8 | | | | 10.8 | 0.72 | | | |
| | thorax left | 7.65 | | | | 14 | 0.55 | | | |
| | thorax right | 7.15 | | | | 16 | 0.45 | | | |
| 9 (Medium) | neck | 249.45 | 111.6 | 85.8 | 82.9 | 6 | 41.6 | 16.3 | 15.9 | 10.8 |
| | back | 80.05 | | | | 3.6 | 22.2 | | | |
| | lumbar | 18.35 | | | | 6 | 3.1 | | | |
| | thorax left | 123.85 | | | | 16 | 7.7 | | | |
| | thorax right | 86.45 | | | | 12.8 | 6.8 | | | |
| 10 (Medium) | neck | 708.45 | 155.1 | 309.5 | 31.7 | 8.8 | 80.5 | 17.1 | 35.4 | 2.8 |
| | back | 8.15 | | | | 10.8 | 0.75 | | | |
| | lumbar | 9.25 | | | | 7.2 | 1.3 | | | |
| | thorax left | 27.9 | | | | 15.2 | 1.8 | | | |
| | thorax right | 21.65 | | | | 18.8 | 1.2 | | | |
| All (Reps. 1 – 10) | neck | 239.3 | 59.8 | 100.6 | 23.2 | 5.8 | 41.2 | 9.5 | 17.7 | 2.8 |
| | back | 13.4 | | | | 8.0 | 3.0 | | | |
| | lumbar | 5.0 | | | | 7.7 | 0.73 | | | |
| | thorax left | 24.0 | | | | 15.2 | 1.6 | | | |
| | thorax right | 17.5 | | | | 15.5 | 1.3 | | | |
| Long (Reps. 1 – 5) | neck | 184.1 | 40.8 | 80.1 | 8.9 | 4.7 | 42.8 | 8.9 | 18.9 | 1.1 |
| | back | 3.7 | | | | 7.9 | 0.66 | | | |
| | lumbar | 1.5 | | | | 7.8 | 0.25 | | | |
| | thorax left | 8.3 | | | | 15.2 | 0.57 | | | |
| | thorax right | 6.7 | | | | 16.6 | 0.39 | | | |
| Medium (Reps. 6 – 10) | neck | 294.5 | 78.8 | 121.1 | 36.5 | 7.0 | 39.6 | 10.2 | 16.5 | 4.3 |
| | back | 23.1 | | | | 8.1 | 5.3 | | | |
| | lumbar | 8.5 | | | | 7.6 | 1.2 | | | |
| | thorax left | 39.6 | | | | 15.2 | 2.6 | | | |
| | thorax right | 28.3 | | | | 14.3 | 2.1 | | | |

Footnotes:

1. Hair samples were dislodged in OT solution.
2. The length of the hair was designated as medium or long by the study author.
3. The distance between the impregnated dog collar and the sampling area averaged 5.6±2.26 cm for the neck, 20.3 ±3.32 cm for the back, 51.9±4.10 cm for the lumbar, 26.4±6.63 cm for the left thorax, and 25.8±6.25 cm for the right thorax.
4. LOQ = 2 µg/sample. Residues were set to ½ LOQ for calculation purposes if the residue was <LOQ.
5. Residues were not corrected for field fortification recoveries. All field fortification recoveries were greater than 90%.

6. Residues were not corrected for concurrent recoveries. It does not appear that laboratory fortified samples were run with the sample sets.
7. The skin surface area is the length of the cut times the width of the cut.
8. Carbaryl residue ($\mu g/cm^2$) = Carbaryl residue ($\mu g$) / skin surface area ($cm^2$).

**Table 8. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Sample Location**

| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Neck | 1 (Long) | 84.6 | 123.3 | 31.7 | 18.4 | 42.4 | 144.1 | 74.1 | 51.6 | 57.8 | 18.4 | 144.1 |
| | 2 (Long) | 395.1 | 108.1 | 19.0 | 7.8 | 11.7 | 22.8 | 94.1 | 152.2 | 34.5 | 7.8 | 395.1 |
| | 3 (Long) | 60.4 | 13.6 | 13.2 | 18.6 | 27.7 | 14.4 | 24.7 | 18.3 | 20.8 | 13.2 | 60.4 |
| | 4 (Long) | 7.9 | 8.9 | 10.8 | 10.2 | 8.0 | 14.3 | 10.0 | 2.4 | 9.8 | 7.9 | 14.3 |
| | 5 (Long) | 28.6 | 40.5 | 11.0 | 43.3 | 17.6 | 18.7 | 26.6 | 13.1 | 23.8 | 11.0 | 43.3 |
| | 6 (Medium) | 5.6 | 35.7 | 7.0 | 6.9 | 6.2 | 16.6 | 13.0 | 11.9 | 9.9 | 5.6 | 35.7 |
| | 7 (Medium) | 4.5 | 7.8 | 11.3 | 15.7 | 9.8 | 49.7 | 16.5 | 16.7 | 12.0 | 4.5 | 49.7 |
| | 8 (Medium) | 5.6 | 3.8 | 71.5 | 22.7 | 14.2 | 9.6 | 21.2 | 25.6 | 13.0 | 3.8 | 71.5 |
| | 9 (Medium) | 2.6 | 8.6 | 68.5 | 97.4 | 59.9 | 41.6 | 46.4 | 36.5 | 26.9 | 2.6 | 97.4 |
| | 10 (Medium) | 79.4 | 128.6 | 83.5 | 214.7 | 120.6 | 80.5 | 117.9 | 52.1 | 110.1 | 79.4 | 214.7 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 67.4 | 47.9 | 32.7 | 45.6 | 31.8 | 41.2 | 44.4 | | | | |
| | Standard Deviation | 119.6 | 51.5 | 29.8 | 65.3 | 35.6 | 42.3 | 37.9 | | | | |
| | Geometric Mean | 20.5 | 24.5 | 22.3 | 23.9 | 20.3 | 28.3 | 32.0 | | | | |
| | Minimum | 2.6 | 3.8 | 7.0 | 6.9 | 6.2 | 9.6 | 10.0 | | | | |
| | Maximum | 395.1 | 128.6 | 83.5 | 214.7 | 120.6 | 144.1 | 117.9 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 115.3 | 58.9 | 17.1 | 19.7 | 21.5 | 42.8 | 45.9 | | | | |
| | Standard Deviation | 159.1 | 53.5 | 8.8 | 14.1 | 13.9 | 56.7 | 36.2 | | | | |
| | Geometric Mean | 53.9 | 36.5 | 15.7 | 16.4 | 18.1 | 26.3 | 34.0 | | | | |
| | Minimum | 7.9 | 8.9 | 10.8 | 7.8 | 8.0 | 14.3 | 10.0 | | | | |
| | Maximum | 395.1 | 123.3 | 31.7 | 43.3 | 42.4 | 144.1 | 94.1 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 19.5 | 36.9 | 48.4 | 71.5 | 42.1 | 39.6 | 43.0 | | | | |
| | Standard Deviation | 33.5 | 52.8 | 36.3 | 87.8 | 49.0 | 28.3 | 43.9 | | | | |
| | Geometric Mean | 7.8 | 16.4 | 31.7 | 34.8 | 22.8 | 30.5 | 30.1 | | | | |
| | Minimum | 2.6 | 3.8 | 7.0 | 6.9 | 6.2 | 9.6 | 13.0 | | | | |
| | Maximum | 79.4 | 128.6 | 83.5 | 214.7 | 120.6 | 80.5 | 117.9 | | | | |

| Table 8. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Back | 1 (Long) | 1.8 | 0.29 | 0.60 | 0.13 | 0.43 | 0.10 | 0.6 | 0.62 | 0.34 | 0.10 | 1.8 |
| | 2 (Long) | 2.6 | 1.2 | 3.3 | 0.94 | 1.1 | 0.44 | 1.6 | 1.1 | 1.3 | 0.4 | 3.3 |
| | 3 (Long) | 6.3 | 3.0 | 2.7 | 2.9 | 7.8 | 1.4 | 4.0 | 2.5 | 3.4 | 1.4 | 7.8 |
| | 4 (Long) | 0.42 | 0.63 | 2.5 | 0.87 | 0.45 | 0.93 | 1.0 | 0.76 | 0.78 | 0.42 | 2.5 |
| | 5 (Long) | 0.78 | 0.46 | 0.90 | 1.6 | 1.2 | 0.39 | 0.90 | 0.48 | 0.80 | 0.39 | 1.6 |
| | 6 (Medium) | 0.48 | 1.1 | 1.8 | 1.3 | 0.80 | 0.57 | 1.0 | 0.48 | 0.90 | 0.48 | 1.8 |
| | 7 (Medium) | 1.2 | 0.93 | 1.0 | 1.5 | 1.5 | 0.91 | 1.2 | 0.27 | 1.1 | 0.91 | 1.5 |
| | 8 (Medium) | 0.88 | 1.0 | 2.4 | 2.2 | 2.0 | 1.9 | 1.8 | 0.65 | 1.6 | 0.88 | 2.4 |
| | 9 (Medium) | 0.75 | 0.51 | 1.9 | 9.5 | 36.6 | 22.2 | 11.9 | 14.7 | 4.2 | 0.51 | 36.6 |
| | 10 (Medium) | 1.2 | 1.0 | 0.94 | 1.5 | 0.93 | 0.75 | 1.1 | 0.3 | 1.0 | 0.75 | 1.5 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 1.6 | 1.0 | 1.8 | 2.3 | 5.3 | 3.0 | 2.5 | | | | |
| | Standard Deviation | 1.7 | 0.77 | 0.92 | 2.7 | 11.2 | 6.8 | 3.5 | | | | |
| | Geometric Mean | 1.2 | 0.83 | 1.6 | 1.4 | 1.7 | 0.9 | 1.5 | | | | |
| | Minimum | 0.4 | 0.29 | 0.60 | 0.13 | 0.43 | 0.10 | 0.55 | | | | |
| | Maximum | 6.3 | 3.0 | 3.3 | 9.5 | 36.6 | 22.2 | 11.9 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 2.4 | 1.1 | 2.0 | 1.3 | 2.2 | 0.66 | 1.6 | | | | |
| | Standard Deviation | 2.3 | 1.1 | 1.2 | 1.0 | 3.1 | 0.53 | 1.4 | | | | |
| | Geometric Mean | 1.6 | 0.79 | 1.6 | 0.86 | 1.2 | 0.47 | 1.3 | | | | |
| | Minimum | 0.42 | 0.29 | 0.60 | 0.13 | 0.43 | 0.10 | 0.55 | | | | |
| | Maximum | 6.3 | 3.0 | 3.3 | 2.9 | 7.8 | 1.4 | 4.0 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.91 | 0.90 | 1.6 | 3.2 | 8.4 | 5.3 | 3.4 | | | | |
| | Standard Deviation | 0.31 | 0.22 | 0.63 | 3.6 | 15.8 | 9.5 | 4.8 | | | | |
| | Geometric Mean | 0.86 | 0.87 | 1.5 | 2.3 | 2.4 | 1.8 | 1.9 | | | | |
| | Minimum | 0.48 | 0.51 | 0.94 | 1.3 | 0.80 | 0.57 | 1.0 | | | | |
| | Maximum | 1.2 | 1.1 | 2.4 | 9.5 | 36.6 | 22.2 | 11.9 | | | | |

| Table 8. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Lumbar | 1 (Long) | 1.1 | 0.22 | 0.53 | 0.13 | 0.12 | 0.10 | 0.36 | 0.38 | 0.24 | 0.10 | 1.1 |
| | 2 (Long) | 2.2 | 0.48 | 0.80 | 0.31 | 0.31 | 0.11 | 0.70 | 0.77 | 0.45 | 0.11 | 2.2 |
| | 3 (Long) | 3.2 | 1.7 | 1.4 | 0.40 | 0.45 | 0.15 | 1.2 | 1.1 | 0.76 | 0.15 | 3.2 |
| | 4 (Long) | 2.9 | 0.53 | 0.94 | 0.13 | 0.11 | 0.12 | 0.79 | 1.1 | 0.36 | 0.11 | 2.9 |
| | 5 (Long) | 2.5 | 2.0 | 0.85 | 1.1 | 0.47 | 0.77 | 1.3 | 0.79 | 1.1 | 0.47 | 2.5 |
| | 6 (Medium) | 0.15 | 0.63 | 0.29 | 0.48 | 0.36 | 0.51 | 0.40 | 0.17 | 0.4 | 0.15 | 0.6 |
| | 7 (Medium) | 22.8 | 1.4 | 0.33 | 0.37 | 1.6 | 0.47 | 4.5 | 9.0 | 1.2 | 0.33 | 22.8 |
| | 8 (Medium) | 0.17 | 0.34 | 1.0 | 1.2 | 0.32 | 0.72 | 0.6 | 0.43 | 0.50 | 0.17 | 1.2 |
| | 9 (Medium) | 0.60 | 0.48 | 0.44 | 0.83 | 2.0 | 3.1 | 1.2 | 1.1 | 0.92 | 0.44 | 3.1 |
| | 10 (Medium) | 0.77 | 0.80 | 0.69 | 0.63 | 1.1 | 1.3 | 0.89 | 0.27 | 0.86 | 0.63 | 1.3 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 3.6 | 0.85 | 0.72 | 0.56 | 0.68 | 0.73 | 1.2 | | | | |
| | Standard Deviation | 6.8 | 0.62 | 0.34 | 0.39 | 0.65 | 0.90 | 1.2 | | | | |
| | Geometric Mean | 1.3 | 0.68 | 0.65 | 0.44 | 0.45 | 0.40 | 0.91 | | | | |
| | Minimum | 0.15 | 0.22 | 0.29 | 0.13 | 0.11 | 0.10 | 0.36 | | | | |
| | Maximum | 22.8 | 2.0 | 1.4 | 1.2 | 2.0 | 3.1 | 4.5 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 2.4 | 1.0 | 0.90 | 0.42 | 0.29 | 0.25 | 0.87 | | | | |
| | Standard Deviation | 0.81 | 0.81 | 0.31 | 0.41 | 0.17 | 0.29 | 0.38 | | | | |
| | Geometric Mean | 2.2 | 0.71 | 0.86 | 0.30 | 0.24 | 0.17 | 0.79 | | | | |
| | Minimum | 1.1 | 0.22 | 0.53 | 0.13 | 0.11 | 0.10 | 0.36 | | | | |
| | Maximum | 3.2 | 2.0 | 1.4 | 1.1 | 0.47 | 0.8 | 1.3 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 4.9 | 0.72 | 0.55 | 0.71 | 1.1 | 1.2 | 1.5 | | | | |
| | Standard Deviation | 10.0 | 0.40 | 0.29 | 0.35 | 0.73 | 1.1 | 1.7 | | | | |
| | Geometric Mean | 0.76 | 0.64 | 0.49 | 0.65 | 0.84 | 0.93 | 1.0 | | | | |
| | Minimum | 0.15 | 0.34 | 0.29 | 0.37 | 0.32 | 0.47 | 0.40 | | | | |
| | Maximum | 22.8 | 1.4 | 1.0 | 1.2 | 2.0 | 3.1 | 4.5 | | | | |

**Table 8. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Sample Location**

| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Thorax left | 1 (Long) | 0.51 | 1.1 | 0.49 | 0.25 | 0.39 | 0.50 | 0.54 | 0.29 | 0.48 | 0.25 | 1.1 |
| | 2 (Long) | 0.12 | 0.30 | 0.37 | 0.20 | 0.18 | 0.09 | 0.21 | 0.11 | 0.19 | 0.09 | 0.37 |
| | 3 (Long) | 0.57 | 0.53 | 0.63 | 0.74 | 0.89 | 0.63 | 0.67 | 0.13 | 0.66 | 0.53 | 0.89 |
| | 4 (Long) | 0.25 | 0.27 | 0.50 | 0.37 | 0.55 | 0.23 | 0.36 | 0.14 | 0.34 | 0.23 | 0.55 |
| | 5 (Long) | 0.18 | 0.31 | 0.91 | 0.50 | 0.85 | 1.4 | 0.69 | 0.45 | 0.55 | 0.18 | 1.4 |
| | 6 (Medium) | 0.53 | 0.61 | 0.86 | 0.84 | 0.93 | 0.78 | 0.76 | 0.16 | 0.74 | 0.53 | 0.93 |
| | 7 (Medium) | 0.85 | 0.56 | 1.1 | 0.85 | 1.2 | 1.9 | 1.1 | 0.48 | 1.0 | 0.56 | 1.9 |
| | 8 (Medium) | 0.18 | 0.54 | 1.0 | 0.38 | 0.47 | 0.55 | 0.52 | 0.27 | 0.46 | 0.18 | 1.0 |
| | 9 (Medium) | 0.14 | 0.57 | 1.1 | 5.7 | 19.3 | 7.7 | 5.8 | 7.3 | 2.0 | 0.14 | 19.3 |
| | 10 (Medium) | 0.50 | 0.74 | 1.3 | 1.5 | 2.6 | 1.8 | 1.4 | 0.77 | 1.2 | 0.50 | 2.6 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.38 | 0.55 | 0.83 | 1.1 | 2.7 | 1.6 | 1.2 | | | | |
| | Standard Deviation | 0.24 | 0.24 | 0.32 | 1.7 | 5.9 | 2.3 | 1.6 | | | | |
| | Geometric Mean | 0.31 | 0.50 | 0.77 | 0.66 | 1.0 | 0.80 | 0.76 | | | | |
| | Minimum | 0.12 | 0.27 | 0.37 | 0.20 | 0.2 | 0.09 | 0.21 | | | | |
| | Maximum | 0.85 | 1.1 | 1.3 | 5.7 | 19.3 | 7.7 | 5.8 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.32 | 0.50 | 0.58 | 0.41 | 0.57 | 0.57 | 0.49 | | | | |
| | Standard Deviation | 0.20 | 0.34 | 0.21 | 0.21 | 0.30 | 0.51 | 0.20 | | | | |
| | Geometric Mean | 0.27 | 0.43 | 0.55 | 0.37 | 0.50 | 0.39 | 0.45 | | | | |
| | Minimum | 0.12 | 0.27 | 0.37 | 0.20 | 0.18 | 0.09 | 0.21 | | | | |
| | Maximum | 0.57 | 1.1 | 0.91 | 0.74 | 0.89 | 1.4 | 0.69 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.44 | 0.6 | 1.1 | 1.9 | 4.9 | 2.6 | 1.9 | | | | |
| | Standard Deviation | 0.29 | 0.1 | 0.16 | 2.2 | 8.1 | 3.0 | 2.2 | | | | |
| | Geometric Mean | 0.35 | 0.6 | 1.1 | 1.2 | 1.9 | 1.6 | 1.3 | | | | |
| | Minimum | 0.14 | 0.54 | 0.86 | 0.38 | 0.47 | 0.55 | 0.52 | | | | |
| | Maximum | 0.85 | 0.7 | 1.3 | 5.7 | 19.3 | 7.7 | 5.8 | | | | |

| Table 8. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm$^2$)[4, 5, 6, 7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Thorax right | 1 (Long) | 2.0 | 5.0 | 0.44 | 0.34 | 0.44 | 0.62 | 1.5 | 1.8 | 0.86 | 0.34 | 5.0 |
| | 2 (Long) | 0.13 | 0.28 | 0.32 | 0.19 | 0.13 | 0.08 | 0.19 | 0.09 | 0.17 | 0.08 | 0.32 |
| | 3 (Long) | 0.69 | 1.4 | 1.2 | 1.0 | 1.3 | 0.44 | 1.0 | 0.37 | 0.92 | 0.44 | 1.4 |
| | 4 (Long) | 0.73 | 0.45 | 0.77 | 0.21 | 0.20 | 0.39 | 0.5 | 0.25 | 0.40 | 0.20 | 0.77 |
| | 5 (Long) | 0.09 | 0.33 | 0.20 | 0.38 | 0.33 | 0.43 | 0.29 | 0.12 | 0.26 | 0.09 | 0.43 |
| | 6 (Medium) | 0.18 | 0.40 | 0.62 | 0.36 | 0.94 | 0.79 | 0.54 | 0.29 | 0.47 | 0.18 | 0.94 |
| | 7 (Medium) | 0.76 | 0.64 | 0.53 | 0.65 | 0.76 | 1.6 | 0.82 | 0.37 | 0.76 | 0.53 | 1.6 |
| | 8 (Medium) | 0.20 | 0.32 | 0.34 | 0.22 | 0.23 | 0.45 | 0.29 | 0.09 | 0.28 | 0.20 | 0.45 |
| | 9 (Medium) | 0.12 | 0.59 | 8.8 | 5.2 | 9.1 | 6.8 | 5.1 | 3.9 | 2.4 | 0.12 | 9.1 |
| | 10 (Medium) | 0.41 | 0.48 | 0.46 | 0.61 | 0.60 | 1.2 | 0.62 | 0.27 | 0.58 | 0.41 | 1.2 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.53 | 1.0 | 1.4 | 0.91 | 1.4 | 1.3 | 1.1 | | | | |
| | Standard Deviation | 0.58 | 1.4 | 2.6 | 1.5 | 2.7 | 2.0 | 1.5 | | | | |
| | Geometric Mean | 0.33 | 0.61 | 0.64 | 0.49 | 0.58 | 0.66 | 0.66 | | | | |
| | Minimum | 0.09 | 0.28 | 0.20 | 0.19 | 0.13 | 0.08 | 0.19 | | | | |
| | Maximum | 2.0 | 5.0 | 8.8 | 5.2 | 9.1 | 6.8 | 5.1 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.7 | 1.5 | 0.59 | 0.42 | 0.48 | 0.39 | 0.68 | | | | |
| | Standard Deviation | 0.8 | 2.0 | 0.40 | 0.31 | 0.47 | 0.20 | 0.54 | | | | |
| | Geometric Mean | 0.4 | 0.78 | 0.48 | 0.35 | 0.35 | 0.32 | 0.52 | | | | |
| | Minimum | 0.1 | 0.28 | 0.20 | 0.19 | 0.13 | 0.078 | 0.19 | | | | |
| | Maximum | 2.0 | 5.0 | 1.2 | 1.0 | 1.3 | 0.62 | 1.5 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.3 | 0.49 | 2.2 | 1.4 | 2.3 | 2.1 | 1.5 | | | | |
| | Standard Deviation | 0.3 | 0.13 | 3.7 | 2.1 | 3.8 | 2.6 | 2.0 | | | | |
| | Geometric Mean | 0.3 | 0.47 | 0.85 | 0.69 | 1.0 | 1.3 | 0.84 | | | | |
| | Minimum | 0.1 | 0.32 | 0.34 | 0.22 | 0.23 | 0.45 | 0.29 | | | | |
| | Maximum | 0.8 | 0.64 | 8.8 | 5.2 | 9.1 | 6.8 | 5.1 | | | | |

**Table 8. Carbaryl Residues in Dislodging OT Solution[1] – Sorted by Sample Location**

| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4,5,6,7] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Average of All Locations | 1 (Long) | 18.0 | 26.0 | 6.7 | 3.8 | 8.8 | 29.1 | 15.4 | 10.6 | 12.1 | 3.8 | 29.1 |
| | 2 (Long) | 80.0 | 22.1 | 4.8 | 1.9 | 2.7 | 4.7 | 19.4 | 30.7 | 7.7 | 1.9 | 80.0 |
| | 3 (Long) | 14.2 | 4.0 | 3.8 | 4.7 | 7.6 | 3.4 | 6.3 | 4.2 | 5.5 | 3.4 | 14.2 |
| | 4 (Long) | 2.4 | 2.1 | 3.1 | 2.4 | 1.9 | 3.2 | 2.5 | 0.52 | 2.5 | 1.9 | 3.2 |
| | 5 (Long) | 6.4 | 8.7 | 2.8 | 9.4 | 4.1 | 4.3 | 6.0 | 2.7 | 5.4 | 2.8 | 9.4 |
| | 6 (Medium) | 1.4 | 7.7 | 2.1 | 2.0 | 1.8 | 3.8 | 3.1 | 2.4 | 2.6 | 1.4 | 7.7 |
| | 7 (Medium) | 6.0 | 2.3 | 2.9 | 3.8 | 3.0 | 10.9 | 4.8 | 3.3 | 4.1 | 2.3 | 10.9 |
| | 8 (Medium) | 1.4 | 1.2 | 15.3 | 5.4 | 3.4 | 2.6 | 4.9 | 5.3 | 3.3 | 1.2 | 15.3 |
| | 9 (Medium) | 0.8 | 2.1 | 16.2 | 23.7 | 25.4 | 16.3 | 14.1 | 10.5 | 8.1 | 0.8 | 25.4 |
| | 10 (Medium) | 16.5 | 26.3 | 17.4 | 43.8 | 25.2 | 17.1 | 24.4 | 10.4 | 22.8 | 16.5 | 43.8 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 14.7 | 10.3 | 7.5 | 10.1 | 8.4 | 9.5 | 10.1 | | | | |
| | Standard Deviation | 23.9 | 10.4 | 6.2 | 13.5 | 9.2 | 8.8 | 7.6 | | | | |
| | Geometric Mean | 5.9 | 5.9 | 5.5 | 5.6 | 5.3 | 6.8 | 7.7 | | | | |
| | Minimum | 0.8 | 1.2 | 2.1 | 1.9 | 1.8 | 2.6 | 2.5 | | | | |
| | Maximum | 80.0 | 26.3 | 17.4 | 43.8 | 25.4 | 29.1 | 24.4 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 24.2 | 12.6 | 4.2 | 4.4 | 5.0 | 8.9 | 9.9 | | | | |
| | Standard Deviation | 31.8 | 10.8 | 1.6 | 3.0 | 3.0 | 11.3 | 7.1 | | | | |
| | Geometric Mean | 12.6 | 8.5 | 4.0 | 3.8 | 4.2 | 5.8 | 7.8 | | | | |
| | Minimum | 2.4 | 2.1 | 2.8 | 1.9 | 1.9 | 3.2 | 2.5 | | | | |
| | Maximum | 80.0 | 26.0 | 6.7 | 9.4 | 8.8 | 29.1 | 19.4 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 5.2 | 7.9 | 10.8 | 15.7 | 11.8 | 10.2 | 10.3 | | | | |
| | Standard Deviation | 6.6 | 10.6 | 7.6 | 18.0 | 12.4 | 6.8 | 9.0 | | | | |
| | Geometric Mean | 2.8 | 4.1 | 7.6 | 8.4 | 6.6 | 7.9 | 7.6 | | | | |
| | Minimum | 0.85 | 1.2 | 2.1 | 2.0 | 1.8 | 2.6 | 3.1 | | | | |
| | Maximum | 16.5 | 26.3 | 17.4 | 43.8 | 25.4 | 17.1 | 24.4 | | | | |

Footnotes:

1. Hair samples were dislodged in OT solution prior to extraction.
2. The distance between the impregnated dog collar and the sampling area averaged 5.6±2.26 cm for the neck, 20.3 ±3.32 cm for the back, 51.9±4.10 cm for the lumbar, 26.4±6.63cm for the left thorax, and 25.8±6.25 cm for the right thorax.
3. The length of the hair was designated as medium or long by the study author.
4. LOQ = 0.2 µg/sample. Residues were set to ½ LOQ for calculation purposes if the residue was <LOQ.
5. Residues were not corrected for field fortification recoveries. All field fortification recoveries were greater than 90%.
6. Residues were not corrected for concurrent recoveries. It does not appear that laboratory fortified samples were run with the sample sets.
7. Carbaryl residue (µg/cm$^2$) = Carbaryl residue (µg) / skin surface area (cm$^2$). The skin surface area is the length of the cut times the width of the cut.

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| *Day 0 (5 hours after application)* | | | | | | | | | | |
| 1 (Long) | neck | 15.02 | 3.8 | 6.3 | 1.7 | 3.6 | 4.2 | 0.93 | 1.8 | 0.21 |
| | back | 1.13 | | | | 6.4 | 0.18 | | | |
| | lumbar | 0.86 | | | | 5.2 | 0.17 | | | |
| | thorax left | 0.79 | | | | 14 | 0.056 | | | |
| | thorax right | 1.34 | | | | 23.2 | 0.058 | | | |
| 2 (Long) | neck | 7.98 | 2.3 | 3.4 | 0.62 | 0.8 | 10.0 | 2.1 | 4.4 | 0.13 |
| | back | 3.19 | | | | 7.6 | 0.42 | | | |
| | lumbar | 0.36 | | | | 1.2 | 0.30 | | | |
| | thorax left | <LOQ | | | | 20 | 0.0050 | | | |
| | thorax right | <LOQ | | | | 20 | 0.0050 | | | |
| 3 (Long) | neck | 1 | 0.7 | 0.2 | 0.67 | 0.4 | 2.5 | 0.66 | 1.0 | 0.27 |
| | back | 0.52 | | | | 1.2 | 0.43 | | | |
| | lumbar | 0.48 | | | | 2 | 0.24 | | | |
| | thorax left | 0.65 | | | | 10.4 | 0.063 | | | |
| | thorax right | 0.82 | | | | 9.2 | 0.089 | | | |
| 4 (Long) | neck | 3.78 | 1.8 | 1.4 | 1.3 | 5.2 | 0.7 | 0.2 | 0.3 | 0.13 |
| | back | 0.62 | | | | 14.8 | 0.0 | | | |
| | lumbar | 1.73 | | | | 6 | 0.29 | | | |
| | thorax left | 0.41 | | | | 14 | 0.029 | | | |
| | thorax right | 2.36 | | | | 19.6 | 0.12 | | | |
| 5 (Long) | neck | 11.18 | 3.0 | 4.6 | 1.5 | 4.8 | 2.3 | 0.55 | 1.0 | 0.16 |
| | back | 1.07 | | | | 10 | 0.11 | | | |
| | lumbar | 0.53 | | | | 2.4 | 0.22 | | | |
| | thorax left | 0.78 | | | | 22 | 0.035 | | | |
| | thorax right | 1.54 | | | | 27.2 | 0.057 | | | |
| 6 (Medium) | neck | 2.24 | 2.0 | 0.5 | 2.0 | 13.2 | 0.17 | 0.1 | 0.1 | 0.13 |
| | back | 1.75 | | | | 9.6 | 0.18 | | | |
| | lumbar | 1.4 | | | | 6.8 | 0.21 | | | |
| | thorax left | 2.65 | | | | 24 | 0.11 | | | |
| | thorax right | 2.2 | | | | 39.6 | 0.056 | | | |
| 7 (Medium) | neck | 1.67 | 2.0 | 0.7 | 1.9 | 4 | 0.42 | 0.5 | 0.5 | 0.29 |
| | back | 1.43 | | | | 2.8 | 0.51 | | | |
| | lumbar | 3.05 | | | | 2.4 | 1.3 | | | |
| | thorax left | 2.29 | | | | 22.4 | 0.10 | | | |
| | thorax right | 1.64 | | | | 20.4 | 0.08 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 1.64 | 1.6 | 0.2 | 1.6 | 2.8 | 0.59 | 0.3 | 0.2 | 0.19 |
| | back | 1.45 | | | | 6.8 | 0.21 | | | |
| | lumbar | 1.83 | | | | 6 | 0.31 | | | |
| | thorax left | 1.39 | | | | 16.8 | 0.083 | | | |
| | thorax right | 1.66 | | | | 22.8 | 0.073 | | | |
| 9 (Medium) | neck | 1.66 | 1.5 | 0.1 | 1.5 | 4 | 0.42 | 0.2 | 0.1 | 0.14 |
| | back | 1.45 | | | | 8 | 0.18 | | | |
| | lumbar | 1.41 | | | | 8 | 0.18 | | | |
| | thorax left | 1.53 | | | | 22 | 0.070 | | | |
| | thorax right | 1.36 | | | | 20 | 0.068 | | | |
| 10 (Medium) | neck | 13.85 | 4.2 | 5.4 | 2.7 | 3.6 | 3.8 | 0.9 | 1.6 | 0.28 |
| | back | 1.79 | | | | 7.6 | 0.24 | | | |
| | lumbar | 1.69 | | | | 6.4 | 0.26 | | | |
| | thorax left | 2.21 | | | | 18 | 0.12 | | | |
| | thorax right | 1.64 | | | | 30 | 0.055 | | | |
| All (Reps. 1 – 10) | neck | 6.0 | 2.3 | 2.1 | 1.8 | 4.2 | 2.5 | 0.6 | 1.0 | 0.25 |
| | back | 1.4 | | | | 7.5 | 0.25 | | | |
| | lumbar | 1.3 | | | | 4.6 | 0.34 | | | |
| | thorax left | 1.3 | | | | 18.4 | 0.068 | | | |
| | thorax right | 1.5 | | | | 23.2 | 0.066 | | | |
| Long (Reps. 1 – 5) | neck | 7.8 | 2.3 | 3.1 | 1.4 | 3.0 | 3.9 | 0.9 | 1.7 | 0.22 |
| | back | 1.3 | | | | 8.0 | 0.24 | | | |
| | lumbar | 0.8 | | | | 3.4 | 0.24 | | | |
| | thorax left | 0.5 | | | | 16.1 | 0.038 | | | |
| | thorax right | 1.2 | | | | 19.8 | 0.066 | | | |
| Medium (Reps. 6 – 10) | neck | 4.2 | 2.3 | 1.1 | 2.1 | 5.5 | 1.1 | 0.4 | 0.4 | 0.24 |
| | back | 1.6 | | | | 7.0 | 0.26 | | | |
| | lumbar | 1.9 | | | | 5.9 | 0.44 | | | |
| | thorax left | 2.0 | | | | 20.6 | 0.10 | | | |
| | thorax right | 1.7 | | | | 26.6 | 0.066 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 1 | | | | | | | | | | |
| 1 (Long) | neck | 73.09 | 18.7 | 30.6 | 6.9 | 7.6 | 9.6 | 2.2 | 4.2 | 0.55 |
| | back | 2.04 | | | | 12.8 | 0.16 | | | |
| | lumbar | 1.5 | | | | 10.8 | 0.14 | | | |
| | thorax left | 7.99 | | | | 15.6 | 0.51 | | | |
| | thorax right | 8.87 | | | | 19.2 | 0.46 | | | |
| 2 (Long) | neck | 20.7 | 6.5 | 8.0 | 4.2 | 5.6 | 3.7 | 0.9 | 1.6 | 0.35 |
| | back | 4.46 | | | | 8.8 | 0.51 | | | |
| | lumbar | 1.7 | | | | 10 | 0.17 | | | |
| | thorax left | 3.25 | | | | 20 | 0.16 | | | |
| | thorax right | 2.58 | | | | 25.6 | 0.10 | | | |
| 3 (Long) | neck | 6.02 | 3.6 | 1.4 | 3.5 | 2.4 | 2.5 | 0.8 | 0.9 | 0.56 |
| | back | 2.98 | | | | 6 | 0.50 | | | |
| | lumbar | 2.54 | | | | 3.6 | 0.71 | | | |
| | thorax left | 2.89 | | | | 12 | 0.24 | | | |
| | thorax right | 3.78 | | | | 14 | 0.27 | | | |
| 4 (Long) | neck | 11.57 | 5.0 | 3.8 | 4.2 | 7.2 | 1.6 | 0.5 | 0.6 | 0.33 |
| | back | 4.08 | | | | 12.8 | 0.32 | | | |
| | lumbar | 2.7 | | | | 10 | 0.27 | | | |
| | thorax left | 2.44 | | | | 18 | 0.14 | | | |
| | thorax right | 4.16 | | | | 20.4 | 0.20 | | | |
| 5 (Long) | neck | 32.34 | 8.2 | 13.5 | 3.8 | 7.6 | 4.3 | 1.0 | 1.8 | 0.34 |
| | back | 2 | | | | 8.4 | 0.24 | | | |
| | lumbar | 1.96 | | | | 3.6 | 0.54 | | | |
| | thorax left | 2.62 | | | | 29.2 | 0.09 | | | |
| | thorax right | 2.26 | | | | 23.6 | 0.10 | | | |
| 6 (Medium) | neck | 40.15 | 9.7 | 17.1 | 3.5 | 20 | 2.0 | 0.5 | 0.8 | 0.21 |
| | back | 1.54 | | | | 8.4 | 0.18 | | | |
| | lumbar | 1.29 | | | | 10.4 | 0.12 | | | |
| | thorax left | 3.05 | | | | 26 | 0.12 | | | |
| | thorax right | 2.29 | | | | 28.4 | 0.081 | | | |
| 7 (Medium) | neck | 8.72 | 4.4 | 2.8 | 3.6 | 6.8 | 1.3 | 0.5 | 0.5 | 0.32 |
| | back | 1.04 | | | | 6 | 0.17 | | | |
| | lumbar | 3.79 | | | | 9.2 | 0.41 | | | |
| | thorax left | 3.19 | | | | 21.2 | 0.15 | | | |
| | thorax right | 5.22 | | | | 21.6 | 0.24 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 4.43 | 2.2 | 1.3 | 2.0 | 6 | 0.74 | 0.2 | 0.3 | 0.16 |
| | back | 1.7 | | | | 8 | 0.21 | | | |
| | lumbar | 1.06 | | | | 13.2 | 0.080 | | | |
| | thorax left | 2.17 | | | | 18.8 | 0.12 | | | |
| | thorax right | 1.73 | | | | 24 | 0.072 | | | |
| 9 (Medium) | neck | 1.7 | 1.4 | 0.5 | 1.3 | 4.4 | 0.39 | 0.1 | 0.1 | 0.11 |
| | back | 0.96 | | | | 16 | 0.060 | | | |
| | lumbar | 0.76 | | | | 10 | 0.076 | | | |
| | thorax left | 1.65 | | | | 18.8 | 0.088 | | | |
| | thorax right | 1.94 | | | | 22.8 | 0.085 | | | |
| 10 (Medium) | neck | 33.78 | 9.1 | 13.8 | 4.5 | 4.8 | 7.0 | 1.5 | 3.1 | 0.33 |
| | back | 1.37 | | | | 8.8 | 0.16 | | | |
| | lumbar | 2.58 | | | | 14 | 0.18 | | | |
| | thorax left | 3.48 | | | | 23.6 | 0.15 | | | |
| | thorax right | 4.22 | | | | 32 | 0.13 | | | |
| All (Reps. 1 – 10) | neck | 23.3 | 6.9 | 9.2 | 4.2 | 7.2 | 3.3 | 0.8 | 1.4 | 0.37 |
| | back | 2.2 | | | | 9.6 | 0.25 | | | |
| | lumbar | 2.0 | | | | 9.5 | 0.27 | | | |
| | thorax left | 3.3 | | | | 20.3 | 0.18 | | | |
| | thorax right | 3.7 | | | | 23.2 | 0.17 | | | |
| Long (Reps. 1 – 5) | neck | 28.7 | 8.4 | 11.4 | 5.0 | 6.1 | 4.3 | 1.1 | 1.8 | 0.49 |
| | back | 3.1 | | | | 9.8 | 0.34 | | | |
| | lumbar | 2.1 | | | | 7.6 | 0.37 | | | |
| | thorax left | 3.8 | | | | 19.0 | 0.23 | | | |
| | thorax right | 4.3 | | | | 20.6 | 0.23 | | | |
| Medium (Reps. 6 – 10) | neck | 17.8 | 5.4 | 7.0 | 3.3 | 8.4 | 2.3 | 0.57 | 1.0 | 0.25 |
| | back | 1.3 | | | | 9.4 | 0.16 | | | |
| | lumbar | 1.9 | | | | 11.4 | 0.18 | | | |
| | thorax left | 2.7 | | | | 21.7 | 0.12 | | | |
| | thorax right | 3.1 | | | | 25.8 | 0.12 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 4 | | | | | | | | | | |
| 1 (Long) | neck | 52.85 | 13.4 | 22.3 | 4.6 | 4 | 13.2 | 2.8 | 5.8 | 0.40 |
| | back | 0.95 | | | | 10 | 0.10 | | | |
| | lumbar | 1.79 | | | | 11.6 | 0.15 | | | |
| | thorax left | 2.76 | | | | 14.8 | 0.19 | | | |
| | thorax right | 8.53 | | | | 29.6 | 0.29 | | | |
| 2 (Long) | neck | 24.7 | 7.8 | 10.0 | 3.8 | 8.4 | 2.9 | 0.87 | 1.2 | 0.29 |
| | back | 9.44 | | | | 8.4 | 1.1 | | | |
| | lumbar | 0.84 | | | | 8.8 | 0.10 | | | |
| | thorax left | 2.19 | | | | 22 | 0.10 | | | |
| | thorax right | 1.87 | | | | 26.8 | 0.07 | | | |
| 3 (Long) | neck | 14.48 | 5.9 | 5.0 | 4.7 | 4 | 3.6 | 1.0 | 1.4 | 0.57 |
| | back | 2.51 | | | | 4.8 | 0.52 | | | |
| | lumbar | 4.5 | | | | 8 | 0.56 | | | |
| | thorax left | 2.54 | | | | 16 | 0.16 | | | |
| | thorax right | 5.7 | | | | 15.6 | 0.37 | | | |
| 4 (Long) | neck | 17.23 | 7.2 | 6.0 | 5.5 | 5.2 | 3.3 | 0.9 | 1.4 | 0.43 |
| | back | 7.46 | | | | 15.6 | 0.48 | | | |
| | lumbar | 1.99 | | | | 9.6 | 0.21 | | | |
| | thorax left | 3.62 | | | | 22.8 | 0.16 | | | |
| | thorax right | 5.58 | | | | 18.8 | 0.30 | | | |
| 5 (Long) | neck | 21.92 | 7.0 | 8.4 | 4.5 | 6.4 | 3.4 | 0.9 | 1.4 | 0.36 |
| | back | 1.87 | | | | 8.8 | 0.21 | | | |
| | lumbar | 2.33 | | | | 9.2 | 0.25 | | | |
| | thorax left | 5.3 | | | | 18.8 | 0.28 | | | |
| | thorax right | 3.78 | | | | 31.2 | 0.12 | | | |
| 6 (Medium) | neck | 15.03 | 7.4 | 5.1 | 5.9 | 10.4 | 1.4 | 0.5 | 0.5 | 0.36 |
| | back | 4.28 | | | | 8 | 0.54 | | | |
| | lumbar | 1.65 | | | | 12.4 | 0.13 | | | |
| | thorax left | 8.58 | | | | 32.4 | 0.26 | | | |
| | thorax right | 7.67 | | | | 35.2 | 0.22 | | | |
| 7 (Medium) | neck | 15.34 | 12.9 | 8.4 | 10.9 | 4.8 | 3.2 | 1.5 | 1.5 | 0.95 |
| | back | 4.9 | | | | 9.6 | 0.51 | | | |
| | lumbar | 26 | | | | 8 | 3.3 | | | |
| | thorax left | 6.73 | | | | 21.6 | 0.31 | | | |
| | thorax right | 11.56 | | | | 24.8 | 0.47 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 2.78 | 4.1 | 1.5 | 3.9 | 3.6 | 0.77 | 0.4 | 0.3 | 0.35 |
| | back | 6.12 | | | | 9.6 | 0.64 | | | |
| | lumbar | 3.83 | | | | 11.2 | 0.34 | | | |
| | thorax left | 5.2 | | | | 19.2 | 0.27 | | | |
| | thorax right | 2.54 | | | | 22.4 | 0.11 | | | |
| 9 (Medium) | neck | 28.15 | 10.2 | 11.4 | 5.4 | 5.6 | 5.0 | 1.3 | 2.1 | 0.46 |
| | back | 3.4 | | | | 11.2 | 0.3 | | | |
| | lumbar | 0.8 | | | | 8.4 | 0.10 | | | |
| | thorax left | 3.87 | | | | 21.2 | 0.18 | | | |
| | thorax right | 14.85 | | | | 20 | 0.74 | | | |
| 10 (Medium) | neck | 77.97 | 21.5 | 32.2 | 8.9 | 8.4 | 9.3 | 2.1 | 4.0 | 0.59 |
| | back | 2.28 | | | | 11.2 | 0.20 | | | |
| | lumbar | 2.76 | | | | 9.6 | 0.29 | | | |
| | thorax left | 18.53 | | | | 26 | 0.71 | | | |
| | thorax right | 5.98 | | | | 32.8 | 0.18 | | | |
| All (Reps. 1 – 10) | neck | 27.0 | 9.8 | 9.7 | 7.4 | 6.1 | 4.6 | 1.2 | 1.9 | 0.61 |
| | back | 4.3 | | | | 9.7 | 0.46 | | | |
| | lumbar | 4.6 | | | | 9.7 | 0.54 | | | |
| | thorax left | 5.9 | | | | 21.5 | 0.26 | | | |
| | thorax right | 6.8 | | | | 25.7 | 0.29 | | | |
| Long (Reps. 1 – 5) | neck | 26.2 | 8.3 | 10.1 | 5.4 | 5.6 | 5.3 | 1.3 | 2.2 | 0.48 |
| | back | 4.4 | | | | 9.5 | 0.49 | | | |
| | lumbar | 2.3 | | | | 9.4 | 0.25 | | | |
| | thorax left | 3.3 | | | | 18.9 | 0.18 | | | |
| | thorax right | 5.1 | | | | 24.4 | 0.23 | | | |
| Medium (Reps. 6 – 10) | neck | 27.9 | 11.2 | 9.5 | 9.0 | 6.6 | 3.9 | 1.2 | 1.6 | 0.70 |
| | back | 4.2 | | | | 9.9 | 0.44 | | | |
| | lumbar | 7.0 | | | | 9.9 | 0.82 | | | |
| | thorax left | 8.6 | | | | 24.1 | 0.35 | | | |
| | thorax right | 8.5 | | | | 27.0 | 0.34 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 14 | | | | | | | | | | |
| 1 (Long) | neck | 64.17 | 17.0 | 26.9 | 5.1 | 7.2 | 8.9 | 2.1 | 3.8 | 0.49 |
| | back | 0.87 | | | | 8 | 0.11 | | | |
| | lumbar | 0.81 | | | | 7.6 | 0.11 | | | |
| | thorax left | 5.61 | | | | 16 | 0.35 | | | |
| | thorax right | 13.59 | | | | 17.6 | 0.77 | | | |
| 2 (Long) | neck | 19.64 | 6.0 | 7.8 | 3.2 | 8.4 | 2.3 | 0.6 | 1.0 | 0.23 |
| | back | 4.34 | | | | 14 | 0.31 | | | |
| | lumbar | 0.52 | | | | 6.4 | 0.08 | | | |
| | thorax left | 2.44 | | | | 22 | 0.11 | | | |
| | thorax right | 3.01 | | | | 27.6 | 0.11 | | | |
| 3 (Long) | neck | 17.62 | 6.0 | 6.6 | 4.2 | 4.4 | 4.0 | 1.1 | 1.6 | 0.51 |
| | back | 3.59 | | | | 6 | 0.60 | | | |
| | lumbar | 1.63 | | | | 7.2 | 0.23 | | | |
| | thorax left | 4.5 | | | | 14 | 0.32 | | | |
| | thorax right | 2.74 | | | | 13.6 | 0.20 | | | |
| 4 (Long) | neck | 20.24 | 6.3 | 7.9 | 3.5 | 4.8 | 4.2 | 1.0 | 1.8 | 0.28 |
| | back | 4.73 | | | | 14.4 | 0.33 | | | |
| | lumbar | 0.64 | | | | 8 | 0.08 | | | |
| | thorax left | 3.06 | | | | 22 | 0.14 | | | |
| | thorax right | 2.78 | | | | 26.4 | 0.11 | | | |
| 5 (Long) | neck | 42.45 | 11.8 | 17.2 | 6.4 | 8.4 | 5.1 | 1.3 | 2.1 | 0.47 |
| | back | 4.54 | | | | 9.2 | 0.49 | | | |
| | lumbar | 2.6 | | | | 6.4 | 0.41 | | | |
| | thorax left | 4.9 | | | | 32.8 | 0.15 | | | |
| | thorax right | 4.31 | | | | 28 | 0.15 | | | |
| 6 (Medium) | neck | 17.13 | 6.4 | 6.3 | 4.4 | 12 | 1.4 | 0.4 | 0.6 | 0.27 |
| | back | 4.36 | | | | 14 | 0.31 | | | |
| | lumbar | 1.19 | | | | 10.4 | 0.11 | | | |
| | thorax left | 6.01 | | | | 26.8 | 0.22 | | | |
| | thorax right | 3.25 | | | | 28 | 0.12 | | | |
| 7 (Medium) | neck | 26.81 | 11.1 | 9.8 | 7.7 | 6 | 4.5 | 1.2 | 1.8 | 0.59 |
| | back | 4 | | | | 10.8 | 0.37 | | | |
| | lumbar | 2.15 | | | | 10.8 | 0.20 | | | |
| | thorax left | 13.28 | | | | 26.8 | 0.50 | | | |
| | thorax right | 9.04 | | | | 20.4 | 0.44 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 19.57 | 6.2 | 7.5 | 4.0 | 6 | 3.3 | 0.8 | 1.4 | 0.31 |
| | back | 4.64 | | | | 8.8 | 0.53 | | | |
| | lumbar | 3.15 | | | | 12 | 0.26 | | | |
| | thorax left | 2.55 | | | | 22 | 0.12 | | | |
| | thorax right | 1.32 | | | | 26 | 0.05 | | | |
| 9 (Medium) | neck | 18.24 | 9.6 | 6.6 | 7.3 | 5.6 | 3.3 | 1.1 | 1.2 | 0.74 |
| | back | 4.78 | | | | 4.8 | 1.0 | | | |
| | lumbar | 1.86 | | | | 10.8 | 0.17 | | | |
| | thorax left | 13.34 | | | | 16.8 | 0.79 | | | |
| | thorax right | 9.87 | | | | 19.2 | 0.51 | | | |
| 10 (Medium) | neck | 90.07 | 22.0 | 38.2 | 7.7 | 8.4 | 10.7 | 2.4 | 4.7 | 0.50 |
| | back | 3.06 | | | | 8.8 | 0.35 | | | |
| | lumbar | 1.74 | | | | 11.6 | 0.15 | | | |
| | thorax left | 8.39 | | | | 22 | 0.38 | | | |
| | thorax right | 6.56 | | | | 42.8 | 0.15 | | | |
| All (Reps. 1 – 10) | neck | 33.6 | 10.2 | 13.2 | 6.0 | 7.1 | 4.8 | 1.2 | 2.0 | 0.50 |
| | back | 3.9 | | | | 9.9 | 0.44 | | | |
| | lumbar | 1.6 | | | | 9.1 | 0.18 | | | |
| | thorax left | 6.4 | | | | 22.1 | 0.31 | | | |
| | thorax right | 5.6 | | | | 25.0 | 0.26 | | | |
| Long (Reps. 1 – 5) | neck | 32.8 | 9.4 | 13.2 | 5.0 | 6.6 | 4.9 | 1.2 | 2.1 | 0.45 |
| | back | 3.6 | | | | 10.3 | 0.37 | | | |
| | lumbar | 1.2 | | | | 7.1 | 0.18 | | | |
| | thorax left | 4.1 | | | | 21.4 | 0.21 | | | |
| | thorax right | 5.3 | | | | 22.6 | 0.27 | | | |
| Medium (Reps. 6 – 10) | neck | 34.4 | 11.1 | 13.3 | 6.9 | 7.6 | 4.6 | 1.2 | 1.9 | 0.53 |
| | back | 4.2 | | | | 9.4 | 0.51 | | | |
| | lumbar | 2.0 | | | | 11.1 | 0.18 | | | |
| | thorax left | 8.7 | | | | 22.9 | 0.40 | | | |
| | thorax right | 6.0 | | | | 27.3 | 0.26 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 21 | | | | | | | | | | |
| 1 (Long) | neck | 127.54 | 32.5 | 53.4 | 10.9 | 4.8 | 26.6 | 5.7 | 11.7 | 0.92 |
| | back | 5.27 | | | | 12.4 | 0.43 | | | |
| | lumbar | 1.16 | | | | 8.4 | 0.14 | | | |
| | thorax left | 12.81 | | | | 21.2 | 0.60 | | | |
| | thorax right | 15.75 | | | | 22.8 | 0.69 | | | |
| 2 (Long) | neck | 44.9 | 10.8 | 19.1 | 4.0 | 6.8 | 6.6 | 1.5 | 2.9 | 0.37 |
| | back | 3.53 | | | | 8.4 | 0.42 | | | |
| | lumbar | 1.18 | | | | 6.8 | 0.17 | | | |
| | thorax left | 2.12 | | | | 18 | 0.12 | | | |
| | thorax right | 2.51 | | | | 21.6 | 0.12 | | | |
| 3 (Long) | neck | 36.68 | 13.3 | 13.9 | 8.6 | 3.2 | 11.5 | 3.0 | 4.8 | 1.15 |
| | back | 14.44 | | | | 6 | 2.4 | | | |
| | lumbar | 2.32 | | | | 7.6 | 0.31 | | | |
| | thorax left | 4.7 | | | | 12 | 0.39 | | | |
| | thorax right | 8.12 | | | | 13.2 | 0.62 | | | |
| 4 (Long) | neck | 30.35 | 9.7 | 12.0 | 5.3 | 8.8 | 3.4 | 0.9 | 1.4 | 0.38 |
| | back | 2.78 | | | | 10.4 | 0.27 | | | |
| | lumbar | 1.22 | | | | 9.2 | 0.13 | | | |
| | thorax left | 9.9 | | | | 24 | 0.41 | | | |
| | thorax right | 4.17 | | | | 28 | 0.15 | | | |
| 5 (Long) | neck | 40.34 | 14.8 | 14.7 | 10.3 | 8.8 | 4.6 | 1.3 | 1.8 | 0.77 |
| | back | 7.6 | | | | 10 | 0.76 | | | |
| | lumbar | 2.87 | | | | 6.4 | 0.45 | | | |
| | thorax left | 12.73 | | | | 24.4 | 0.52 | | | |
| | thorax right | 10.45 | | | | 30.8 | 0.34 | | | |
| 6 (Medium) | neck | 26.73 | 9.6 | 10.3 | 5.6 | 16 | 1.7 | 0.6 | 0.6 | 0.36 |
| | back | 2.06 | | | | 10 | 0.21 | | | |
| | lumbar | 1.29 | | | | 12 | 0.11 | | | |
| | thorax left | 11 | | | | 25.2 | 0.44 | | | |
| | thorax right | 7.09 | | | | 18 | 0.39 | | | |
| 7 (Medium) | neck | 38.18 | 18.1 | 12.5 | 14.9 | 8 | 4.8 | 1.7 | 1.7 | 1.31 |
| | back | 5.76 | | | | 7.2 | 0.80 | | | |
| | lumbar | 10.78 | | | | 7.2 | 1.5 | | | |
| | thorax left | 20.57 | | | | 22.4 | 0.92 | | | |
| | thorax right | 15.04 | | | | 20.8 | 0.72 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 28.05 | 8.9 | 11.0 | 5.3 | 5.2 | 5.4 | 1.3 | 2.3 | 0.45 |
| | back | 8.3 | | | | 10 | 0.83 | | | |
| | lumbar | 1.95 | | | | 10 | 0.20 | | | |
| | thorax left | 3.68 | | | | 18.8 | 0.20 | | | |
| | thorax right | 2.62 | | | | 24.8 | 0.11 | | | |
| 9 (Medium) | neck | 48.38 | 24.3 | 17.2 | 14.3 | 6.8 | 7.1 | 2.6 | 2.7 | 1.42 |
| | back | 30.18 | | | | 11.6 | 2.6 | | | |
| | lumbar | 0.95 | | | | 7.6 | 0.13 | | | |
| | thorax left | 20.19 | | | | 12 | 1.7 | | | |
| | thorax right | 21.71 | | | | 14.8 | 1.5 | | | |
| 10 (Medium) | neck | 117.94 | 31.2 | 48.8 | 13.3 | 6 | 19.7 | 4.4 | 8.5 | 0.98 |
| | back | 2.66 | | | | 12.4 | 0.21 | | | |
| | lumbar | 7.24 | | | | 16 | 0.45 | | | |
| | thorax left | 18.13 | | | | 12.8 | 1.4 | | | |
| | thorax right | 9.95 | | | | 30.4 | 0.33 | | | |
| All (Reps. 1 – 10) | neck | 53.9 | 17.3 | 20.7 | 10.9 | 7.4 | 9.1 | 2.3 | 3.8 | 0.99 |
| | back | 8.3 | | | | 9.8 | 0.89 | | | |
| | lumbar | 3.1 | | | | 9.1 | 0.36 | | | |
| | thorax left | 11.6 | | | | 19.1 | 0.67 | | | |
| | thorax right | 9.7 | | | | 22.5 | 0.49 | | | |
| Long (Reps. 1 – 5) | neck | 56.0 | 16.2 | 22.4 | 8.5 | 6.5 | 10.5 | 2.5 | 4.5 | 0.80 |
| | back | 6.7 | | | | 9.4 | 0.86 | | | |
| | lumbar | 1.8 | | | | 7.7 | 0.24 | | | |
| | thorax left | 8.5 | | | | 19.9 | 0.41 | | | |
| | thorax right | 8.2 | | | | 23.3 | 0.38 | | | |
| Medium (Reps. 6 – 10) | neck | 51.9 | 18.4 | 19.1 | 13.0 | 8.4 | 7.7 | 2.1 | 3.1 | 1.14 |
| | back | 9.8 | | | | 10.2 | 0.93 | | | |
| | lumbar | 4.4 | | | | 10.6 | 0.48 | | | |
| | thorax left | 14.7 | | | | 18.2 | 0.93 | | | |
| | thorax right | 11.3 | | | | 21.8 | 0.60 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| Day 28 | | | | | | | | | | |
| 1 (Long) | neck | 160.9 | 37.5 | 69.3 | 6.2 | 4 | 40.2 | 8.4 | 17.8 | 0.62 |
| | back | 0.54 | | | | 10 | 0.05 | | | |
| | lumbar | 0.72 | | | | 10.4 | 0.07 | | | |
| | thorax left | 9.62 | | | | 16.8 | 0.57 | | | |
| | thorax right | 15.6 | | | | 14.8 | 1.1 | | | |
| 2 (Long) | neck | 63.06 | 14.0 | 27.4 | 3.5 | 4.4 | 14.3 | 3.0 | 6.3 | 0.41 |
| | back | 2.4 | | | | 7.6 | 0.32 | | | |
| | lumbar | 0.95 | | | | 9.2 | 0.10 | | | |
| | thorax left | 1.66 | | | | 11.6 | 0.14 | | | |
| | thorax right | 2.14 | | | | 12.8 | 0.17 | | | |
| 3 (Long) | neck | 44.1 | 11.9 | 18.1 | 5.4 | 6 | 7.4 | 1.8 | 3.1 | 0.71 |
| | back | 1.99 | | | | 3.6 | 0.55 | | | |
| | lumbar | 1.52 | | | | 6.8 | 0.22 | | | |
| | thorax left | 7.24 | | | | 11.6 | 0.62 | | | |
| | thorax right | 4.85 | | | | 14.8 | 0.33 | | | |
| 4 (Long) | neck | 34.54 | 9.4 | 14.2 | 4.0 | 3.2 | 10.8 | 2.4 | 4.7 | 0.47 |
| | back | 2.12 | | | | 3.6 | 0.59 | | | |
| | lumbar | 0.69 | | | | 8.4 | 0.08 | | | |
| | thorax left | 3.38 | | | | 22 | 0.15 | | | |
| | thorax right | 6.04 | | | | 22 | 0.27 | | | |
| 5 (Long) | neck | 62.12 | 19.3 | 24.6 | 10.8 | 6 | 10.4 | 2.6 | 4.3 | 1.07 |
| | back | 4.24 | | | | 14.8 | 0.29 | | | |
| | lumbar | 3.38 | | | | 4.4 | 0.77 | | | |
| | thorax left | 17.61 | | | | 14 | 1.3 | | | |
| | thorax right | 9.16 | | | | 18.8 | 0.49 | | | |
| 6 (Medium) | neck | 23.65 | 8.6 | 8.8 | 5.9 | 7.2 | 3.3 | 1.0 | 1.3 | 0.56 |
| | back | 2.27 | | | | 10 | 0.23 | | | |
| | lumbar | 2.42 | | | | 6.8 | 0.36 | | | |
| | thorax left | 7.95 | | | | 18 | 0.44 | | | |
| | thorax right | 6.86 | | | | 14.4 | 0.48 | | | |
| 7 (Medium) | neck | 91.21 | 27.2 | 36.4 | 14.2 | 6.8 | 13.4 | 3.6 | 5.5 | 1.61 |
| | back | 5.39 | | | | 8.8 | 0.61 | | | |
| | lumbar | 3.74 | | | | 7.2 | 0.52 | | | |
| | thorax left | 19.44 | | | | 12.8 | 1.5 | | | |
| | thorax right | 16.23 | | | | 9.6 | 1.7 | | | |

**Table 9. Carbaryl Residues in Dislodged Hair Extracts[1] – Sorted by Replicate**

| Replicate No. (Length of Hair)[2] | Sample Location[3] | Carbaryl Residue of Individual Parts[4,5,6] (µg) | Carbaryl Residue (µg) | | | Skin Surface Area[7] ($cm^2$) | Carbaryl Residue of Individual Parts (µg/$cm^2$) | Carbaryl Residue (µg/$cm^2$)[8] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average | St. Dev. | Geometric Mean | | | Average | St. Dev. | Geometric Mean |
| 8 (Medium) | neck | 28.94 | 9.3 | 11.1 | 6.2 | 6 | 4.8 | 1.3 | 2.0 | 0.61 |
| | back | 6.97 | | | | 7.2 | 1.0 | | | |
| | lumbar | 3.46 | | | | 10.8 | 0.32 | | | |
| | thorax left | 3.65 | | | | 14 | 0.26 | | | |
| | thorax right | 3.59 | | | | 16 | 0.22 | | | |
| 9 (Medium) | neck | 37.33 | 26.0 | 18.8 | 18.8 | 6 | 6.2 | 3.2 | 2.2 | 2.45 |
| | back | 13.17 | | | | 3.6 | 3.7 | | | |
| | lumbar | 3.71 | | | | 6 | 0.62 | | | |
| | thorax left | 24.97 | | | | 16 | 1.6 | | | |
| | thorax right | 50.94 | | | | 12.8 | 4.0 | | | |
| 10 (Medium) | neck | 101.16 | 26.8 | 41.9 | 10.5 | 8.8 | 11.5 | 2.8 | 4.9 | 0.92 |
| | back | 1.86 | | | | 10.8 | 0.17 | | | |
| | lumbar | 3.66 | | | | 7.2 | 0.51 | | | |
| | thorax left | 13.45 | | | | 15.2 | 0.88 | | | |
| | thorax right | 13.78 | | | | 18.8 | 0.73 | | | |
| All (Reps. 1 – 10) | neck | 64.7 | 19.0 | 25.9 | 9.8 | 5.8 | 12.2 | 3.0 | 5.2 | 1.18 |
| | back | 4.1 | | | | 8.0 | 0.74 | | | |
| | lumbar | 2.4 | | | | 7.7 | 0.36 | | | |
| | thorax left | 10.9 | | | | 15.2 | 0.74 | | | |
| | thorax right | 12.9 | | | | 15.5 | 0.94 | | | |
| Long (Reps. 1 – 5) | neck | 72.9 | 18.4 | 30.6 | 6.8 | 4.7 | 16.6 | 3.6 | 7.2 | 0.82 |
| | back | 2.3 | | | | 7.9 | 0.36 | | | |
| | lumbar | 1.5 | | | | 7.8 | 0.25 | | | |
| | thorax left | 7.9 | | | | 15.2 | 0.55 | | | |
| | thorax right | 7.6 | | | | 16.6 | 0.46 | | | |
| Medium (Reps. 6 – 10) | neck | 56.5 | 19.6 | 21.5 | 12.4 | 7.0 | 7.8 | 2.4 | 3.1 | 1.40 |
| | back | 5.9 | | | | 8.1 | 1.1 | | | |
| | lumbar | 3.4 | | | | 7.6 | 0.46 | | | |
| | thorax left | 13.9 | | | | 15.2 | 0.93 | | | |
| | thorax right | 18.3 | | | | 14.3 | 1.4 | | | |

Footnotes:

1. Hair samples were dislodged in OT solution prior to extraction.
2. The length of the hair was designated as medium or long by the study author.
3. The distance between the impregnated dog collar and the sampling area averaged 5.6±2.26 cm for the neck, 20.3 ±3.32 cm for the back, 51.9±4.10 cm for the lumbar, 26.4±6.63 cm for the left thorax, and 25.8±6.25 cm for the right thorax.
4. LOQ = 0.2 µg/sample for hair extracts. Residues were set to ½ LOQ for calculation purposes if the residue was <LOQ.
5. Residues were not corrected for field fortification recoveries. All field fortification recoveries were greater than 90%.
6. Residues were not corrected for concurrent recoveries. It does not appear that laboratory fortified samples were run with the sample sets.
7. The skin surface area is the length of the cut times the width of the cut.
8. Carbaryl residue (µg/cm$^2$) = Carbaryl Residue (µg) / skin surface area (cm$^2$).

| Table 10. Carbaryl Residues (µg/cm²) in Dislodged Hair Extract[1]– Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4,5,6,7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Neck | 1 (long) | 4.2 | 9.6 | 13.2 | 8.9 | 26.6 | 40.2 | 17.1 | 13.6 | 13.1 | 4.2 | 40.2 |
| | 2 (long) | 10.0 | 3.7 | 2.9 | 2.3 | 6.6 | 14.3 | 6.6 | 4.7 | 5.4 | 2.3 | 14.3 |
| | 3 (long) | 2.5 | 2.5 | 3.6 | 4.0 | 11.5 | 7.4 | 5.2 | 3.5 | 4.4 | 2.5 | 11.5 |
| | 4 (long) | 0.73 | 1.6 | 3.3 | 4.2 | 3.4 | 10.8 | 4.0 | 3.6 | 2.9 | 0.7 | 10.8 |
| | 5 (long) | 2.3 | 4.3 | 3.4 | 5.1 | 4.6 | 10.4 | 5.0 | 2.8 | 4.5 | 2.3 | 10.4 |
| | 6 (medium) | 0.17 | 2.0 | 1.4 | 1.4 | 1.7 | 3.3 | 1.7 | 1.0 | 1.3 | 0.2 | 3.3 |
| | 7 (medium) | 0.42 | 1.3 | 3.2 | 4.5 | 4.8 | 13.4 | 4.6 | 4.7 | 2.8 | 0.4 | 13.4 |
| | 8 (medium) | 0.59 | 0.7 | 0.8 | 3.3 | 5.4 | 4.8 | 2.6 | 2.2 | 1.7 | 0.6 | 5.4 |
| | 9 (medium) | 0.4 | 0.4 | 5.0 | 3.3 | 7.1 | 6.2 | 3.7 | 2.9 | 2.2 | 0.4 | 7.1 |
| | 10 (medium) | 3.8 | 7.0 | 9.3 | 10.7 | 19.7 | 11.5 | 10.3 | 5.3 | 9.2 | 3.8 | 19.7 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 2.5 | 3.3 | 4.6 | 4.8 | 9.1 | 12.2 | 6.1 | | | | |
| | Standard Deviation | 3.0 | 3.0 | 3.8 | 2.9 | 8.0 | 10.5 | 4.5 | | | | |
| | Geometric Mean | 1.3 | 2.2 | 3.5 | 4.1 | 6.7 | 9.7 | 5.0 | | | | |
| | Minimum | 0.17 | 0.39 | 0.77 | 1.4 | 1.7 | 3.3 | 1.7 | | | | |
| | Maximum | 10.0 | 9.6 | 13.2 | 10.7 | 26.6 | 40.2 | 17.1 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 3.9 | 4.3 | 5.3 | 4.9 | 10.5 | 16.6 | 7.6 | | | | |
| | Standard Deviation | 3.6 | 3.1 | 4.4 | 2.4 | 9.5 | 13.4 | 5.4 | | | | |
| | Geometric Mean | 2.8 | 3.6 | 4.4 | 4.5 | 8.0 | 13.6 | 6.5 | | | | |
| | Minimum | 0.7 | 1.6 | 2.9 | 2.3 | 3.4 | 7.4 | 4.0 | | | | |
| | Maximum | 10.0 | 9.6 | 13.2 | 8.9 | 26.6 | 40.2 | 17.1 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 1.1 | 2.3 | 3.9 | 4.6 | 7.7 | 7.8 | 4.6 | | | | |
| | Standard Deviation | 1.6 | 2.7 | 3.4 | 3.6 | 7.0 | 4.4 | 3.4 | | | | |
| | Geometric Mean | 0.6 | 1.4 | 2.8 | 3.7 | 5.7 | 6.9 | 3.8 | | | | |

| Table 10. Carbaryl Residues (µg/cm$^2$) in Dislodged Hair Extract[1]– Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm$^2$)[4, 5, 6, 7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| | Minimum | 0.2 | 0.4 | 0.8 | 1.4 | 1.7 | 3.3 | 1.7 | | | | |
| | Maximum | 3.8 | 7.0 | 9.3 | 10.7 | 19.7 | 13.4 | 10.3 | | | | |

| Table 10. Carbaryl Residues (µg/cm²) in Dislodged Hair Extract[1] – Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Back | 1 (long) | 0.18 | 0.16 | 0.10 | 0.11 | 0.43 | 0.054 | 0.17 | 0.13 | 0.14 | 0.05 | 0.43 |
| | 2 (long) | 0.42 | 0.51 | 1.12 | 0.31 | 0.42 | 0.32 | 0.52 | 0.31 | 0.46 | 0.31 | 1.1 |
| | 3 (long) | 0.43 | 0.50 | 0.52 | 0.60 | 2.41 | 0.55 | 0.84 | 0.77 | 0.67 | 0.43 | 2.4 |
| | 4 (long) | 0.04 | 0.32 | 0.48 | 0.33 | 0.27 | 0.59 | 0.34 | 0.19 | 0.26 | 0.04 | 0.59 |
| | 5 (long) | 0.11 | 0.24 | 0.21 | 0.49 | 0.76 | 0.29 | 0.35 | 0.24 | 0.29 | 0.11 | 0.76 |
| | 6 (medium) | 0.18 | 0.18 | 0.54 | 0.31 | 0.21 | 0.23 | 0.27 | 0.14 | 0.25 | 0.18 | 0.54 |
| | 7 (medium) | 0.51 | 0.17 | 0.51 | 0.37 | 0.80 | 0.61 | 0.50 | 0.21 | 0.45 | 0.17 | 0.80 |
| | 8 (medium) | 0.21 | 0.21 | 0.64 | 0.53 | 0.83 | 0.97 | 0.56 | 0.31 | 0.48 | 0.21 | 0.97 |
| | 9 (medium) | 0.18 | 0.06 | 0.30 | 1.00 | 2.60 | 3.66 | 1.30 | 1.5 | 0.56 | 0.06 | 3.7 |
| | 10 (medium) | 0.24 | 0.16 | 0.20 | 0.35 | 0.21 | 0.17 | 0.22 | 0.07 | 0.21 | 0.16 | 0.35 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.25 | 0.25 | 0.46 | 0.44 | 0.89 | 0.74 | 0.51 | | | | |
| | Standard Deviation | 0.15 | 0.15 | 0.29 | 0.24 | 0.88 | 1.06 | 0.34 | | | | |
| | Geometric Mean | 0.20 | 0.21 | 0.38 | 0.38 | 0.61 | 0.41 | 0.42 | | | | |
| | Minimum | 0.042 | 0.060 | 0.10 | 0.11 | 0.21 | 0.054 | 0.17 | | | | |
| | Maximum | 0.51 | 0.51 | 1.12 | 1.00 | 2.60 | 3.66 | 1.30 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.24 | 0.34 | 0.49 | 0.37 | 0.86 | 0.36 | 0.44 | | | | |
| | Standard Deviation | 0.18 | 0.15 | 0.40 | 0.19 | 0.89 | 0.22 | 0.25 | | | | |
| | Geometric Mean | 0.17 | 0.31 | 0.36 | 0.32 | 0.61 | 0.28 | 0.39 | | | | |
| | Minimum | 0.04 | 0.16 | 0.10 | 0.11 | 0.27 | 0.054 | 0.17 | | | | |
| | Maximum | 0.43 | 0.51 | 1.12 | 0.60 | 2.41 | 0.59 | 0.84 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.26 | 0.16 | 0.44 | 0.51 | 0.93 | 1.13 | 0.57 | | | | |
| | Standard Deviation | 0.14 | 0.06 | 0.18 | 0.28 | 0.98 | 1.45 | 0.43 | | | | |
| | Geometric Mean | 0.24 | 0.14 | 0.40 | 0.46 | 0.60 | 0.61 | 0.47 | | | | |
| | Minimum | 0.18 | 0.06 | 0.20 | 0.31 | 0.21 | 0.17 | 0.22 | | | | |
| | Maximum | 0.51 | 0.21 | 0.64 | 1.00 | 2.60 | 3.66 | 1.30 | | | | |

**Table 10. Carbaryl Residues (µg/cm²) in Dislodged Hair Extract[1]– Sorted by Sample Location**

| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Lumbar | 1 (long) | 0.17 | 0.14 | 0.15 | 0.11 | 0.14 | 0.07 | 0.13 | 0.035 | 0.12 | 0.07 | 0.17 |
| | 2 (long) | 0.30 | 0.17 | 0.10 | 0.081 | 0.17 | 0.10 | 0.15 | 0.082 | 0.14 | 0.08 | 0.30 |
| | 3 (long) | 0.24 | 0.71 | 0.56 | 0.23 | 0.31 | 0.22 | 0.38 | 0.21 | 0.34 | 0.22 | 0.71 |
| | 4 (long) | 0.29 | 0.27 | 0.21 | 0.080 | 0.13 | 0.08 | 0.18 | 0.09 | 0.16 | 0.08 | 0.29 |
| | 5 (long) | 0.22 | 0.54 | 0.25 | 0.41 | 0.45 | 0.77 | 0.44 | 0.20 | 0.40 | 0.22 | 0.77 |
| | 6 (medium) | 0.21 | 0.12 | 0.13 | 0.11 | 0.11 | 0.36 | 0.17 | 0.10 | 0.16 | 0.11 | 0.36 |
| | 7 (medium) | 1.27 | 0.41 | 3.25 | 0.20 | 1.50 | 0.52 | 1.19 | 1.1 | 0.80 | 0.20 | 3.3 |
| | 8 (medium) | 0.31 | 0.080 | 0.34 | 0.26 | 0.20 | 0.32 | 0.25 | 0.10 | 0.23 | 0.08 | 0.34 |
| | 9 (medium) | 0.18 | 0.076 | 0.10 | 0.17 | 0.13 | 0.62 | 0.21 | 0.20 | 0.16 | 0.08 | 0.62 |
| | 10 (medium) | 0.26 | 0.18 | 0.29 | 0.15 | 0.45 | 0.51 | 0.31 | 0.14 | 0.28 | 0.15 | 0.51 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.34 | 0.27 | 0.54 | 0.18 | 0.36 | 0.36 | 0.34 | | | | |
| | Standard Deviation | 0.33 | 0.21 | 0.96 | 0.10 | 0.42 | 0.24 | 0.32 | | | | |
| | Geometric Mean | 0.28 | 0.21 | 0.27 | 0.16 | 0.24 | 0.27 | 0.27 | | | | |
| | Minimum | 0.17 | 0.08 | 0.10 | 0.08 | 0.11 | 0.069 | 0.13 | | | | |
| | Maximum | 1.27 | 0.71 | 3.25 | 0.41 | 1.50 | 0.77 | 1.19 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.24 | 0.37 | 0.25 | 0.18 | 0.24 | 0.25 | 0.26 | | | | |
| | Standard Deviation | 0.05 | 0.25 | 0.18 | 0.14 | 0.14 | 0.30 | 0.14 | | | | |
| | Geometric Mean | 0.24 | 0.30 | 0.21 | 0.14 | 0.21 | 0.16 | 0.23 | | | | |
| | Minimum | 0.17 | 0.14 | 0.10 | 0.080 | 0.13 | 0.069 | 0.13 | | | | |
| | Maximum | 0.30 | 0.71 | 0.56 | 0.41 | 0.45 | 0.77 | 0.44 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.44 | 0.18 | 0.82 | 0.18 | 0.48 | 0.46 | 0.43 | | | | |
| | Standard Deviation | 0.46 | 0.14 | 1.36 | 0.06 | 0.59 | 0.12 | 0.43 | | | | |
| | Geometric Mean | 0.33 | 0.14 | 0.33 | 0.17 | 0.28 | 0.45 | 0.32 | | | | |
| | Minimum | 0.18 | 0.08 | 0.10 | 0.11 | 0.11 | 0.32 | 0.17 | | | | |
| | Maximum | 1.27 | 0.41 | 3.25 | 0.26 | 1.50 | 0.62 | 1.19 | | | | |

**Table 10. Carbaryl Residues (µg/cm²) in Dislodged Hair Extract[1] – Sorted by Sample Location**

| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Thorax left | 1 (long) | 0.056 | 0.51 | 0.19 | 0.35 | 0.60 | 0.57 | 0.38 | 0.22 | 0.29 | 0.06 | 0.60 |
| | 2 (long) | 0.0050 | 0.16 | 0.10 | 0.11 | 0.12 | 0.14 | 0.11 | 0.055 | 0.073 | 0.01 | 0.16 |
| | 3 (long) | 0.063 | 0.24 | 0.16 | 0.32 | 0.39 | 0.62 | 0.30 | 0.20 | 0.24 | 0.063 | 0.62 |
| | 4 (long) | 0.029 | 0.14 | 0.16 | 0.14 | 0.41 | 0.15 | 0.17 | 0.13 | 0.13 | 0.029 | 0.41 |
| | 5 (long) | 0.035 | 0.09 | 0.28 | 0.15 | 0.52 | 1.26 | 0.39 | 0.46 | 0.21 | 0.035 | 1.3 |
| | 6 (medium) | 0.11 | 0.12 | 0.26 | 0.22 | 0.44 | 0.44 | 0.27 | 0.15 | 0.23 | 0.11 | 0.44 |
| | 7 (medium) | 0.10 | 0.15 | 0.31 | 0.50 | 0.92 | 1.52 | 0.58 | 0.55 | 0.39 | 0.10 | 1.5 |
| | 8 (medium) | 0.083 | 0.12 | 0.27 | 0.12 | 0.20 | 0.26 | 0.17 | 0.08 | 0.16 | 0.083 | 0.27 |
| | 9 (medium) | 0.070 | 0.09 | 0.18 | 0.79 | 1.68 | 1.56 | 0.73 | 0.74 | 0.36 | 0.070 | 1.7 |
| | 10 (medium) | 0.123 | 0.15 | 0.71 | 0.38 | 1.42 | 0.88 | 0.61 | 0.50 | 0.43 | 0.12 | 1.4 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.068 | 0.18 | 0.26 | 0.31 | 0.67 | 0.74 | 0.37 | | | | |
| | Standard Deviation | 0.038 | 0.13 | 0.17 | 0.21 | 0.52 | 0.54 | 0.21 | | | | |
| | Geometric Mean | 0.052 | 0.15 | 0.23 | 0.25 | 0.51 | 0.55 | 0.32 | | | | |
| | Minimum | 0.005 | 0.088 | 0.10 | 0.11 | 0.12 | 0.14 | 0.11 | | | | |
| | Maximum | 0.12 | 0.51 | 0.71 | 0.79 | 1.68 | 1.56 | 0.73 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.038 | 0.23 | 0.18 | 0.21 | 0.41 | 0.55 | 0.27 | | | | |
| | Standard Deviation | 0.023 | 0.17 | 0.07 | 0.11 | 0.18 | 0.46 | 0.13 | | | | |
| | Geometric Mean | 0.028 | 0.19 | 0.17 | 0.19 | 0.36 | 0.40 | 0.24 | | | | |
| | Minimum | 0.005 | 0.09 | 0.10 | 0.11 | 0.12 | 0.14 | 0.11 | | | | |
| | Maximum | 0.063 | 0.51 | 0.28 | 0.35 | 0.60 | 1.26 | 0.39 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.10 | 0.12 | 0.35 | 0.40 | 0.93 | 0.93 | 0.47 | | | | |
| | Standard Deviation | 0.02 | 0.03 | 0.21 | 0.26 | 0.63 | 0.60 | 0.24 | | | | |
| | Geometric Mean | 0.10 | 0.12 | 0.31 | 0.33 | 0.72 | 0.75 | 0.41 | | | | |
| | Minimum | 0.070 | 0.09 | 0.18 | 0.12 | 0.20 | 0.26 | 0.17 | | | | |
| | Maximum | 0.12 | 0.15 | 0.71 | 0.79 | 1.68 | 1.56 | 0.73 | | | | |

**Table 10. Carbaryl Residues (µg/cm²) in Dislodged Hair Extract[1] – Sorted by Sample Location**

| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Thorax right | 1 (long) | 0.058 | 0.46 | 0.29 | 0.77 | 0.69 | 1.05 | 0.55 | 0.36 | 0.40 | 0.058 | 1.05 |
| | 2 (long) | 0.0050 | 0.10 | 0.07 | 0.11 | 0.12 | 0.17 | 0.09 | 0.054 | 0.065 | 0.005 | 0.17 |
| | 3 (long) | 0.089 | 0.27 | 0.37 | 0.20 | 0.62 | 0.33 | 0.31 | 0.18 | 0.27 | 0.089 | 0.62 |
| | 4 (long) | 0.120 | 0.20 | 0.30 | 0.11 | 0.15 | 0.27 | 0.19 | 0.081 | 0.18 | 0.11 | 0.30 |
| | 5 (long) | 0.057 | 0.10 | 0.12 | 0.15 | 0.34 | 0.49 | 0.21 | 0.17 | 0.16 | 0.057 | 0.49 |
| | 6 (medium) | 0.056 | 0.08 | 0.22 | 0.12 | 0.39 | 0.48 | 0.22 | 0.18 | 0.17 | 0.056 | 0.48 |
| | 7 (medium) | 0.080 | 0.24 | 0.47 | 0.44 | 0.72 | 1.69 | 0.61 | 0.57 | 0.41 | 0.080 | 1.7 |
| | 8 (medium) | 0.073 | 0.072 | 0.11 | 0.051 | 0.11 | 0.22 | 0.11 | 0.062 | 0.095 | 0.051 | 0.22 |
| | 9 (medium) | 0.068 | 0.085 | 0.74 | 0.51 | 1.47 | 3.98 | 1.14 | 1.5 | 0.48 | 0.068 | 4.0 |
| | 10 (medium) | 0.055 | 0.13 | 0.18 | 0.15 | 0.33 | 0.73 | 0.26 | 0.25 | 0.19 | 0.055 | 0.73 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.066 | 0.17 | 0.29 | 0.26 | 0.49 | 0.94 | 0.37 | | | | |
| | Standard Deviation | 0.030 | 0.12 | 0.20 | 0.24 | 0.41 | 1.16 | 0.32 | | | | |
| | Geometric Mean | 0.054 | 0.14 | 0.23 | 0.19 | 0.36 | 0.58 | 0.28 | | | | |
| | Minimum | 0.005 | 0.072 | 0.070 | 0.051 | 0.11 | 0.17 | 0.09 | | | | |
| | Maximum | 0.12 | 0.46 | 0.74 | 0.77 | 1.5 | 4.0 | 1.1 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.066 | 0.23 | 0.23 | 0.27 | 0.38 | 0.46 | 0.27 | | | | |
| | Standard Deviation | 0.043 | 0.15 | 0.13 | 0.28 | 0.26 | 0.35 | 0.18 | | | | |
| | Geometric Mean | 0.045 | 0.19 | 0.19 | 0.19 | 0.30 | 0.38 | 0.23 | | | | |
| | Minimum | 0.0050 | 0.10 | 0.07 | 0.11 | 0.12 | 0.17 | 0.09 | | | | |
| | Maximum | 0.12 | 0.46 | 0.37 | 0.77 | 0.69 | 1.1 | 0.55 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.066 | 0.12 | 0.34 | 0.26 | 0.60 | 1.4 | 0.47 | | | | |
| | Standard Deviation | 0.011 | 0.07 | 0.26 | 0.21 | 0.53 | 1.5 | 0.42 | | | | |
| | Geometric Mean | 0.066 | 0.11 | 0.27 | 0.18 | 0.43 | 0.88 | 0.34 | | | | |
| | Minimum | 0.055 | 0.07 | 0.11 | 0.05 | 0.11 | 0.22 | 0.11 | | | | |
| | Maximum | 0.080 | 0.24 | 0.74 | 0.51 | 1.5 | 4.0 | 1.1 | | | | |

| Table 10. Carbaryl Residues (µg/cm²) in Dislodged Hair Extract[1] – Sorted by Sample Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location[2] | Replicate No. (Length of Hair)[3] | Carbaryl Residues (µg/cm²)[4, 5, 6, 7] | | | | | | | | | | |
| | | Sampling Interval (Day) | | | | | | All Sampling Intervals | | | | |
| | | 0 | 1 | 4 | 7 | 14 | 28 | Average | St. Dev. | Geometric Mean | Minimum | Maximum |
| Average of All Locations | 1 (long) | 0.9 | 2.2 | 2.8 | 2.1 | 5.7 | 8.4 | 3.7 | 2.8 | 2.9 | 0.93 | 8.4 |
| | 2 (long) | 2.1 | 0.93 | 0.87 | 0.59 | 1.5 | 3.0 | 1.5 | 0.92 | 1.29 | 0.59 | 3.0 |
| | 3 (long) | 0.66 | 0.84 | 1.0 | 1.1 | 3.0 | 1.8 | 1.4 | 0.89 | 1.23 | 0.66 | 3.0 |
| | 4 (long) | 0.24 | 0.51 | 0.89 | 1.0 | 0.9 | 2.4 | 1.0 | 0.74 | 0.78 | 0.24 | 2.4 |
| | 5 (long) | 0.55 | 1.0 | 0.86 | 1.3 | 1.3 | 2.6 | 1.3 | 0.72 | 1.14 | 0.55 | 2.6 |
| | 6 (medium) | 0.14 | 0.50 | 0.52 | 0.4 | 0.6 | 1.0 | 0.5 | 0.26 | 0.46 | 0.14 | 0.96 |
| | 7 (medium) | 0.48 | 0.45 | 1.5 | 1.2 | 1.7 | 3.6 | 1.5 | 1.1 | 1.16 | 0.45 | 3.6 |
| | 8 (medium) | 0.25 | 0.24 | 0.4 | 0.84 | 1.3 | 1.3 | 0.7 | 0.51 | 0.58 | 0.24 | 1.3 |
| | 9 (medium) | 0.18 | 0.14 | 1.3 | 1.1 | 2.6 | 3.2 | 1.4 | 1.3 | 0.82 | 0.14 | 3.2 |
| | 10 (medium) | 0.90 | 1.5 | 2.1 | 2.4 | 4.4 | 2.8 | 2.3 | 1.2 | 2.1 | 0.90 | 4.4 |
| | All (Reps. 1 – 10) | | | | | | | | | | | |
| | Average | 0.65 | 0.84 | 1.2 | 1.2 | 2.3 | 3.0 | 1.5 | | | | |
| | Standard Deviation | 0.60 | 0.63 | 0.74 | 0.60 | 1.6 | 2.1 | 0.90 | | | | |
| | Geometric Mean | 0.47 | 0.6 | 1.1 | 1.1 | 1.8 | 2.5 | 1.3 | | | | |
| | Minimum | 0.14 | 0.1 | 0.4 | 0.44 | 0.56 | 1.0 | 0.52 | | | | |
| | Maximum | 2.1 | 2.2 | 2.8 | 2.4 | 5.7 | 8.4 | 3.7 | | | | |
| | Long Hair Length (Reps. 1 – 5) | | | | | | | | | | | |
| | Average | 0.90 | 1.1 | 1.3 | 1.2 | 2.5 | 3.6 | 1.8 | | | | |
| | Standard Deviation | 0.73 | 0.63 | 0.84 | 0.54 | 2.0 | 2.7 | 1.1 | | | | |
| | Geometric Mean | 0.7 | 1.0 | 1.1 | 1.1 | 2.0 | 3.1 | 1.6 | | | | |
| | Minimum | 0.24 | 0.51 | 0.86 | 0.59 | 0.88 | 1.8 | 1.0 | | | | |
| | Maximum | 2.1 | 2.2 | 2.8 | 2.1 | 5.7 | 8.4 | 3.7 | | | | |
| | Medium Hair Length (Reps. 6 – 10) | | | | | | | | | | | |
| | Average | 0.39 | 0.57 | 1.2 | 1.2 | 2.1 | 2.4 | 1.3 | | | | |
| | Standard Deviation | 0.31 | 0.56 | 0.72 | 0.71 | 1.5 | 1.2 | 0.72 | | | | |
| | Geometric Mean | 0.31 | 0.41 | 1.0 | 1.0 | 1.7 | 2.1 | 1.1 | | | | |
| | Minimum | 0.14 | 0.14 | 0.43 | 0.44 | 0.56 | 1.0 | 0.52 | | | | |
| | Maximum | 0.90 | 1.5 | 2.1 | 2.4 | 4.4 | 3.6 | 2.3 | | | | |

Footnotes:

1. Hair samples were dislodged in OT solution prior to extraction.
2. The distance between the impregnated dog collar and the sampling area averaged 5.6±2.26 cm for the neck, 20.3 ±3.32 cm for the back, 51.9±4.10 cm for the lumbar, 26.4±6.63cm for the left thorax, and 25.8±6.25 cm for the right thorax .
3. The length of the hair was designated as medium or long by the study author.
4. LOQ = 0.2 µg/sample for hair extracts. Residues were set to ½ LOQ for calculation purposes if the residue was <LOQ.
5. Residues were not corrected for field fortification recoveries. All field fortification recoveries were greater than 90%.
6. Residues were not corrected for concurrent recoveries. It does not appear that laboratory fortified samples were run with the sample sets.
7. Carbaryl residue (µg/cm$^2$) = Carbaryl residue (µg) / skin surface area (cm$^2$). The skin surface area is the length of the cut times the width of the cut.

| Table 11. Summary of Carbaryl Residue (µg/cm²) in OT Solution (All Replicates Combined) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample Location | Statistic | Sampling Interval (Day) Residue in µg/cm² | | | | | | Average Residue µg/cm² |
| | | 0 | 1 | 4 | 7 | 14 | 28 | |
| neck | **Average** | **67.4** | **47.9** | **32.7** | **45.6** | **31.8** | **41.2** | **44.4** |
| | Standard Deviation | 119.6 | 51.5 | 29.8 | 65.3 | 35.6 | 42.3 | 37.9 |
| | Geometric Mean | 20.5 | 24.5 | 22.3 | 23.9 | 20.3 | 28.3 | 32.0 |
| back | **Average** | **1.6** | **1.0** | **1.8** | **2.3** | **5.3** | **3.0** | **2.5** |
| | Standard Deviation | 1.7 | 0.77 | 0.92 | 2.7 | 11.2 | 6.8 | 3.5 |
| | Geometric Mean | 1.2 | 0.83 | 1.6 | 1.4 | 1.7 | 0.9 | 1.5 |
| lumbar | **Average** | **3.6** | **0.85** | **0.72** | **0.56** | **0.68** | **0.73** | **1.2** |
| | Standard Deviation | 6.8 | 0.62 | 0.34 | 0.39 | 0.65 | 0.90 | 1.2 |
| | Geometric Mean | 1.3 | 0.68 | 0.65 | 0.44 | 0.45 | 0.40 | 0.91 |
| thorax left | **Average** | **0.38** | **0.55** | **0.83** | **1.1** | **2.7** | **1.6** | **1.2** |
| | Standard Deviation | 0.24 | 0.24 | 0.32 | 1.7 | 5.9 | 2.3 | 1.6 |
| | Geometric Mean | 0.31 | 0.50 | 0.77 | 0.66 | 1.0 | 0.80 | 0.76 |
| thorax right | **Average** | **0.53** | **1.0** | **1.4** | **0.91** | **1.4** | **1.3** | **1.1** |
| | Standard Deviation | 0.58 | 1.4 | 2.6 | 1.5 | 2.7 | 2.0 | 1.5 |
| | Geometric Mean | 0.33 | 0.61 | 0.64 | 0.49 | 0.58 | 0.66 | 0.66 |
| All Locations | **Average** | **14.7** | **10.3** | **7.5** | **10.1** | **8.4** | **9.5** | **10.1** |
| | Standard Deviation | 23.9 | 10.4 | 6.2 | 13.5 | 9.2 | 8.8 | 7.6 |
| | Geometric Mean | 5.9 | 5.9 | 5.5 | 5.6 | 5.3 | 6.8 | 7.7 |

| Table 12. Summary of Carbaryl Residue (µg/cm$^2$) in Hair Extracts (All Replicates Combined) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample Location | Statistic | Sampling Interval (Day) Residues in µg/cm$^2$ | | | | | | Average Residue µg/cm$^2$ |
| | | 0 (5 hours after application) | 1 | 4 | 7 | 14 | 28 | |
| neck | **Average** | **2.5** | **3.3** | **4.6** | **4.8** | **9.1** | **12.2** | **6.1** |
| | Standard Deviation | 3.0 | 3.0 | 3.8 | 2.9 | 8.0 | 10.5 | 4.5 |
| | Geometric Mean | 1.3 | 2.2 | 3.5 | 4.1 | 6.7 | 9.7 | 5.0 |
| back | **Average** | **0.25** | **0.25** | **0.46** | **0.44** | **0.89** | **0.74** | **0.51** |
| | Standard Deviation | 0.15 | 0.15 | 0.29 | 0.24 | 0.88 | 1.06 | 0.34 |
| | Geometric Mean | 0.20 | 0.21 | 0.38 | 0.38 | 0.61 | 0.41 | 0.42 |
| lumbar | **Average** | **0.34** | **0.27** | **0.54** | **0.18** | **0.36** | **0.36** | **0.34** |
| | Standard Deviation | 0.33 | 0.21 | 0.96 | 0.10 | 0.42 | 0.24 | 0.32 |
| | Geometric Mean | 0.28 | 0.21 | 0.27 | 0.16 | 0.24 | 0.27 | 0.27 |
| thorax left | **Average** | **0.068** | **0.18** | **0.26** | **0.31** | **0.67** | **0.74** | **0.37** |
| | Standard Deviation | 0.038 | 0.13 | 0.17 | 0.21 | 0.52 | 0.54 | 0.21 |
| | Geometric Mean | 0.052 | 0.15 | 0.23 | 0.25 | 0.51 | 0.55 | 0.32 |
| thorax right | **Average** | **0.066** | **0.17** | **0.29** | **0.26** | **0.49** | **0.94** | **0.37** |
| | Standard Deviation | 0.030 | 0.12 | 0.20 | 0.24 | 0.41 | 1.16 | 0.32 |
| | Geometric Mean | 0.054 | 0.14 | 0.23 | 0.19 | 0.36 | 0.58 | 0.28 |
| All Locations | **Average** | **0.65** | **0.84** | **1.2** | **1.2** | **2.3** | **3.0** | **1.5** |
| | Standard Deviation | 0.60 | 0.63 | 0.74 | 0.60 | 1.6 | 2.1 | 0.90 |
| | Geometric Mean | 0.47 | 0.6 | 1.1 | 1.1 | 1.8 | 2.5 | 1.3 |

# APPENDIX A

## Compliance Checklist for "Determination of Dislodgeable Residues of Carbaryl From the Hair of Dogs Wearing Collars Impregnated with Carbaryl"

**COMPLIANCE CHECKLIST**
**Applicable Checklist Items Taken from:**
**GUIDELINE 875.2300: INDOOR SURFACE RESIDUE DISSIPATION POSTAPPLICATION and**
**GUIDELINE 875.2100: DISLODGEABLE FOLIAR RESIDUE DISSIPATION**

1. *The test substance must be the typical end use product of the active ingredient.*
   This criterion was met.

2. *The production of metabolites, breakdown products, or the presence of contaminants of potential toxicologic concern, should be considered on a case-by-case basis.*
   It is uncertain if this criterion was met. Samples were only analyzed for carbaryl and the Report did not provide any discussion of metabolites or break-down products.

3. *Ambient conditions (i.e., temperature, barometric pressure, ventilation) should be monitored.* This criterion was met, as applicable. Temperature and rainfall was monitored.

4. *The end use product should be applied by the application method recommended on the label. Information that verifies that the application equipment (e.g., sprayer) was properly calibrated should be included.*
   This criterion was met. Manual application was made by the same person for each dog.

5. *The application rate used in the study should be provided and should be the maximum rate specified on the label. However, monitoring following application at a typical application rate is more appropriate in certain cases.*
   This criterion was met.

6. *Indoor surface residue (ISR) data should be collected from several different types of media (e.g., carpeting, hard surface flooring, counter tops, or other relevant materials).*
   This criterion was met in that samples were taken from both medium and long-haired dogs. According to the study author, the sampling method precluded the use of short-haired dogs.

7. *Sampling should be sufficient to characterize the dissipation mechanisms of the compound (e.g., three half-lives or 72 hours after application, unless the compound has been found to fully dissipate in less time; for more persistent pesticides, longer sampling periods may be necessary). Sampling intervals may be relatively short in the beginning and lengthen as the study progresses. Background samples should be collected before application of the test substance occurs.*
   This criterion was not met. The impregnated pet collar is designed to slowly release, over a 120-day period, the active ingredient in concentrations sufficient to control the target pests. The data collected during the 28-day sampling period indicates that the release/dissipation is not linear during that 28-day period. A sampling protocol that included sampling at intervals throughout the 120-day period would have provided a more accurate characterization of the chemical release and dissipation properties of the active ingredient.

8. *Samples should be collected using a suitable methodology (e.g., California Cloth Roller, Polyurethane Roller, Drag Sled, Coupons, Wipe Samples, Hand Press, vacuum cleaners for dust and debris, etc.) for indoor surfaces.*
   This criterion was met, the dog hair was clipped off and dislodged.

9. *Control plots should be established from which sufficient control samples can be collected. Control sites should be upwind and a reasonable distance from the treatment site.*
   This criterion was met as control dogs were used.

10. *If multiple applications are made, the minimum allowable interval between applications should be used.*
    Not applicable.

11. *Samples should be stored in a manner that will minimize deterioration and loss of analytes between collection*

*and analysis. Information on storage stability should be provided.*

This criterion was most likely met. Samples were stored frozen and field fortification and storage stability studies were conducted. The storage duration of the experimental samples was not provided, therefore, it could not be confirmed that the storage duration of the field fortified and storage stability samples adequately covered the storage duration of the experimental samples.

12. *Validated analytical methods of sufficient sensitivity are needed. Information on method efficiency (residue recovery), and limit of quantitation (LOQ) should be provided.*

This criterion was met.

13. *Information on recovery samples must be included in the study report. A complete set of field recoveries should consist of at least one blank control sample and three or more each of a low-level and high-level fortification. These fortifications should be in the range of anticipated residue levels in the field study.*

This criterion was partially met. Field forticiation was conducted on two sampling days at two fortication level, in triplicate.

14. *Raw residue data must be corrected if appropriate recovery values are less than 90 percent.*

This criterion was met.

15. *Indoor surface residues should be reported as mg or µg per $m^2$ or $cm^2$ of surface sampled. Distributional data should be reported, to the extent possible.*

This criterion was met.

16. *Residues should be dislodged from leaf surfaces using an aqueous surfactant solution within a reasonable time period (i.e., EPA recommends that dislodging occur within 4 hours). Dislodging should be repeated at least once and the resultant solutions pooled for analysis.*

It is unknown if this criterion was met entirely. Samples were dislodged twice using an aqueous surfactant solution on the day of sample collection. It is unknown if the samples were dislodged in 4 hours.

# APPENDIX B

## Review of Registrant Submitted Human Health Risk Assessment "Exposure and Risk Assessment for Carbaryl Dog Collars Using Data from a Clipping Study"

The registrant, Wellmark International, submitted a human health risk assessment, "Exposure and Risk Assessment for Carbaryl Dog Collars Using Data from a Clipping Study (MRID 47739401)," in conjunction with the study report, "Determination of Dislodgeable Residues of Carbaryl from the Hair of Dogs Wearing Collars Impregnated with Carbaryl (MRID 47739402)." The registrant risk assessment was reviewed and a number of issues have been identified which preclude its use to inform EPA's updated human health risk assessment of the flea collar product.

The product, Zodiac Flea Collar, is a 17.7% carbaryl product formulated for use on dogs in residential settings. The Health Effects Division (HED) anticipates that exposure is likely to occur during (adult only) and following (adults and toddlers) application of the flea collar. The study was generated in support of requirement for data to confirm the Agency's human health safety finding for the residential use of the product.

The registrant submission identified two methods for human health risk assessment employed citing personal communication between Wellmark International and the Agency (OPP) on April 4, 2008 and the reference document, "Current Guidance for Residential Exposure Assessment for Pet Pesticide Treatments (W. Britton, D350531, January 2009). The first method makes use of EPA standard guidance for the assessment of exposure from pet insecticidal products as was described in the January 2009 reference document. The second uses probabilistic algorithms and distributions to generate a deterministic estimate citing April 2008 personal communication. The following addresses the two methods employed by the registrant and a description of issues identified.

The residential SOP concerning exposure to treated pets is currently under revision. Until the completion of this process, including review by the Scientific Advisory Panel (SAP), the Agency has continued to rely upon current methods for assessing exposure from treated pets. In order to assess the potential risk from the use of pet insecticidal products, HED relies upon a series of assumptions and exposure factors which serve as the basis for completing a residential risk assessment. The series of assumptions and exposure factors which serve as the basis for estimating the exposures (dermal and incidental oral) are derived from the "HED Standard Operating Procedures (SOPs) for Residential Exposure Assessments (December 19, 1997)" and the 1999 Draft Policy 13, "Postapplication Exposure Assessment for Children from Treated Pets." These scientifically validated methods result in a deterministic, or point, estimate of potential risk from exposure to the insecticidal product. HED communicated to the Wellmark International that this is the currently preferred method of estimation of risk from exposure to a treated pet. The algorithms and inputs were provided to Wellmark International via the above referred January 2009 guidance document. These same methods were employed by the Agency for the assessment of estimated risk from carbaryl pet collars in the June 9, 2008 document, "Carbaryl: Revisions to Residential Exposure and Risk Assessment," using default assumptions to calculate transferable residue ($\mu g/cm^2$).

The registrant submission (first method) describes that EPA standard assumptions for risk estimation were employed to generate an estimate of residential risk. However, the registrant did not identify the transferable residue input ($\mu g/cm^2$) identified from the study results and used to generate this estimate. Further, no rationale is provided for the selection of the unidentified input.

The registrant provided a second method for estimating risk estimates from exposure to the Zodiac Flea Collar. The submission cites personal communication with HED in April 2008 (as referenced above). HED verifies the communication with the registrant and that guidance was provided at the meeting; the Agency instructed Wellmark International that a probabilistic risk assessment could be generated and submitted using the algorithms and inputs, with corresponding data distributions, as was performed in the EPA document "n-Methyl Carbamate (NMC) Revised Cumulative Risk Assessment (September 24, 2007)." The registrant submitted risk assessment attempts to use the algorithms and inputs from the Agency's probabilistic risk assessment to generate a deterministic estimate. The January 2009 guidance document further elaborates that,

in lieu of a deterministic assessment, "a probabilistic risk assessment method is also appropriate for the assessment of human health risk from exposure to pet insecticides." Additional guidance outlined in the document includes, "In the probabilistic model, the risk assessor should establish, characterize and validate the distributions used for the deterministic data inputs. Current, publicly available models include CARES (Cumulative and Aggregate Risk Evaluation System), Calendex™, and SHEDS (Stochastic Human Exposure and Dose Simulation Model for Pesticides). The Agency will consider probabilistic assessments submitted by registrants under chemical review for use in risk characterization."

The Agency cannot rely upon the registrant's second method/approach for several reasons. 1) The algorithms and inputs, and corresponding data distributions, have been scientifically validated (USEPA, 2005) for probabilistic risk assessment use only. They have not been validated for the estimation of a deterministic estimate of risk. 2) The algorithms and inputs were designed for use only in a probabilistic model. 3) The registrant does not identify the inputs selected and used from data distributions described in the NMC Revised Cumulative Risk Assessment for estimation of incidental oral (hand-to-mouth) exposures to toddlers. 4) Nor does the registrant describe a rationale for selection of the individual inputs used.

Based upon the above issues identified with the methods employed by the registrant, the Agency is precluded from using the submission to inform the updated assessment of human health from exposure to the flea collar product.

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