Chemicals EDA

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In our first assignment, we looked at different chemicals used on strawberries. Whether it was a Fungicide, Insecticide, Herbicide, or Other, we want to know whether or not eating strawberries is actually killing us in the long run.

I have decided to use the USDA Pesticide Data Program sample data to test whether or not we should stop eating strawberries or if it was safe to continue snacking on our favorite fruit. And if it was safe to eat, how much can we eat before it becomes too dangerous. I got this idea from the radiation banana theory, how every banana contains some radiation. However it is so minuscule that you would have to eat 10 million bananas to die from radiation poisoning which is obviously not an issue as there are numerous more ways I can think of that you will die from trying to eat 10 million bananas.

```
#Loading libraries
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
library(knitr)
library(kableExtra)
```

```
Attaching package: 'kableExtra'

The following object is masked from 'package:dplyr':

    group_rows
```

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v forcats   1.0.0     v readr     2.1.5
v ggplot2   3.5.1     v stringr   1.5.1
v lubridate 1.9.3     v tibble    3.2.1
v purrr     1.0.2     v tidyr     1.3.1

-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter()          masks stats::filter()
x kableExtra::group_rows() masks dplyr::group_rows()
x dplyr::lag()             masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becor
```

```
library(stringr)

#Reading in the data set
usdaSample <- read.csv("usda_chem_sample_data.csv")
```

Now, we will look at all the different Pesticide names that are within this data set.

```
unique(usdaSample$Pesticide.Name)
```

```
 [1] "Malathion"
 [2] "Myclobutanil"
 [3] "Carbendazim (MBC)"
 [4] "Thiamethoxam"
 [5] "Trifloxystrobin"
 [6] "Pyraclostrobin"
 [7] "Boscalid"
 [8] "Azoxystrobin"
 [9] "Tetrahydrophthalimide (THPI)"
[10] "Flonicamid"
```

```
[11] "Fenpropathrin"
[12] "Methoxyfenozide"
[13] "Cyprodinil"
[14] "Fluopyram"
[15] "Metalaxyl/Mefenoxam"
[16] "Novaluron"
[17] "Pyrimethanil"
[18] "Acetamiprid"
[19] "Chlorantraniliprole"
[20] "Bifenthrin"
[21] "Fenhexamid"
[22] "Fludioxonil"
[23] "Tetraconazole"
[24] "Imidacloprid"
[25] "Tebuconazole"
[26] "Spinosad A"
[27] "Flutriafol"
[28] "Spinetoram"
[29] "Carbaryl"
[30] "Piperonyl butoxide"
[31] "Propiconazole"
[32] "Hexythiazox"
[33] "Malathion oxygen analog"
[34] "Pronamide"
[35] "Buprofezin"
[36] "Pyriproxyfen"
[37] "Captan"
[38] "Triflumizole"
[39] "Fluopicolide"
[40] "Spiromesifen"
[41] "Fenpyroximate"
[42] "Oxydemeton methyl"
[43] "Fenazaquin"
[44] "Difenoconazole"
[45] "Dichlorvos (DDVP)"
[46] "Acephate"
[47] "Thiabendazole"
[48] "Quinoxyfen"
[49] "Iprodione"
[50] "Chlorpyrifos"
[51] "Chlorothalonil"
[52] "Methamidophos"
[53] "Triforine"
```

```
[54] "Deltamethrin  (includes parent Tralomethrin)"
[55] "Pirimiphos methyl"
[56] "Dimethomorph"
[57] "Procymidone"
[58] "Propamocarb hydrochloride"
[59] "Endosulfan sulfate"
[60] "Oxydemeton methyl sulfone"
[61] "Flubendiamide"
[62] "Spirotetramat"
[63] "Diflubenzuron"
[64] "1-Naphthol"
[65] "Diuron"
[66] "Cypermethrin"
[67] "Dimethoate"
[68] "Chlorfenapyr"
[69] "Carbofuran"
[70] "Pyridaben"
[71] "Diazinon"
[72] "Dicofol p,p'"
```

Now that we have the entire list of all the pesticides we have, we will look at the "dangerous" ones. We find this by looking at the USDA-NASS data cleaning-ver7.qmd. At the bottom, we can see the "Six deadly carcinogens from WHO list" section which lists the 6 deadly carcinogens.

captafol

ethylene dibromide

glyphosate

malathion

diazinon

dichlorophenyltrichloroethane

Now, from the USDA Pesticide Data Program sample data 'Pesticide Name' column, we can see that Captan, Malathion, Diazinon, and Dichlorvos are on the list are similar to the list above. Therefore, we will be testing whether or not these specific pesticides are safe to consume in strawberries.

But before we do, let's get rid of the columns that we don't really need.

```
usdaNew <- usdaSample %>% select(-Sample.ID, -Commodity, -Pesticide.Code, -LOD, -pp_, -Annota
```

Now, we are only left with the Pesticide Name, Concentration, and EPA Tolerance (ppm). The only information we really need.

Captan

Now we will start my analyzing Captan.

```
captan <- usdaNew |>
  filter(Pesticide.Name == "Captan")
captan
```

```
    Pesticide.Name Concentration EPA.Tolerance..ppm.
1           Captan         0.590                20.0
2           Captan         0.065                20.0
3           Captan         0.047                20.0
4           Captan         0.130                20.0
5           Captan         0.170                20.0
6           Captan         0.100                20.0
7           Captan         0.030                20.0
8           Captan         0.063                20.0
9           Captan         0.110                20.0
10          Captan         0.120                20.0
11          Captan         0.038                20.0
12          Captan         0.068                20.0
13          Captan         0.140                20.0
14          Captan         0.040                20.0
15          Captan         0.076                20.0
16          Captan         0.055                20.0
17          Captan         0.240                20.0
18          Captan         1.300                20.0
19          Captan         0.140                20.0
20          Captan         0.230                20.0
21          Captan         0.200                20.0
22          Captan         0.160                20.0
23          Captan         0.310                20.0
24          Captan         0.170                20.0
25          Captan         0.100                20.0
26          Captan         0.044                20.0
27          Captan         0.033                20.0
28          Captan         0.035                20.0
29          Captan         0.170                20.0
```

30	Captan	0.065	20.0
31	Captan	0.042	20.0
32	Captan	0.084	20.0
33	Captan	0.460	20.0
34	Captan	0.100	20.0
35	Captan	0.230	20.0
36	Captan	0.280	20.0
37	Captan	0.051	20.0
38	Captan	0.070	20.0
39	Captan	0.089	20.0
40	Captan	0.110	20.0
41	Captan	0.790	20.0
42	Captan	0.062	20.0
43	Captan	0.081	20.0
44	Captan	0.110	20.0
45	Captan	0.028	20.0
46	Captan	0.028	20.0
47	Captan	0.110	20.0
48	Captan	0.025	20.0
49	Captan	0.200	20.0
50	Captan	0.035	20.0
51	Captan	0.920	20.0
52	Captan	3.200	20.0
53	Captan	0.051	20.0
54	Captan	0.140	20.0
55	Captan	0.200	20.0
56	Captan	0.093	20.0
57	Captan	0.300	20.0
58	Captan	0.071	20.0
59	Captan	0.036	20.0
60	Captan	0.160	20.0
61	Captan	0.028	20.0
62	Captan	0.170	20.0
63	Captan	0.050	20.0
64	Captan	0.210	20.0
65	Captan	0.100	20.0
66	Captan	0.470	20.0
67	Captan	0.230	20.0
68	Captan	0.027	20.0
69	Captan	0.190	20.0
70	Captan	0.048	20.0
71	Captan	0.200	20.0
72	Captan	1.100	20.0

73	Captan	0.044	20.0
74	Captan	0.120	20.0
75	Captan	0.077	20.0
76	Captan	0.130	20.0
77	Captan	0.220	20.0
78	Captan	0.063	20.0
79	Captan	0.046	20.0
80	Captan	0.070	20.0
81	Captan	0.068	20.0
82	Captan	0.035	20.0
83	Captan	0.042	20.0
84	Captan	0.300	20.0
85	Captan	0.210	20.0
86	Captan	0.310	20.0
87	Captan	0.530	20.0
88	Captan	0.490	20.0
89	Captan	0.190	20.0
90	Captan	0.033	20.0
91	Captan	0.060	20.0
92	Captan	0.100	20.0
93	Captan	0.035	20.0
94	Captan	0.069	20.0
95	Captan	0.130	20.0
96	Captan	0.030	20.0
97	Captan	0.033	20.0
98	Captan	0.032	20.0
99	Captan	0.320	20.0
100	Captan	0.030	20.0
101	Captan	0.031	20.0
102	Captan	0.110	20.0
103	Captan	0.027	20.0
104	Captan	0.110	20.0
105	Captan	0.058	20.0
106	Captan	0.025	20.0
107	Captan	0.032	20.0
108	Captan	0.025	20.0
109	Captan	0.160	20.0
110	Captan	0.170	20.0
111	Captan	0.110	20.0
112	Captan	0.034	20.0
113	Captan	0.092	20.0
114	Captan	0.040	20.0
115	Captan	0.220	20.0

```
116         Captan          0.150               20.0
117         Captan          5.600               20.0
118         Captan          0.027               20.0
119         Captan          0.120               20.0
120         Captan          0.120               20.0
121         Captan          0.026               20.0
122         Captan          0.064               20.0
123         Captan          0.120               20.0
124         Captan          0.033               20.0
125         Captan          0.069               20.0
126         Captan          0.460               20.0
127         Captan          0.086               20.0
```

Now that we got all of Captan isolated, we will look at specific values: the Maximum and the Mean.

```
a <- max(captan$Concentration, na.rm = TRUE)
b <- mean(captan$Concentration, na.rm = TRUE)

cat("The maximum value of Captan concentration in strawberries is:", a)
```

```
The maximum value of Captan concentration in strawberries is: 5.6
```

```
cat("\nThe average value of Captan concentration in strawberries is:", b)
```

```
The average value of Captan concentration in strawberries is: 0.2201102
```

There seemed to be 2 outliers (5.6 and 3.2) that were over 5 times greater than any other value, so I found the outliers and also tried doing this again after taking out the outliers to see our results.

```
a <- max(captanNew$Concentration, na.rm = TRUE)
b <- mean(captanNew$Concentration, na.rm = TRUE)

cat("The maximum value of Captan concentration in strawberries is:", a)
```

```
The maximum value of Captan concentration in strawberries is: 1.3
```

```
cat("\nThe average value of Captan concentration in strawberries is:", b)
```

```
The average value of Captan concentration in strawberries is: 0.153232
```

Now from looking up online, the EPA's Reference Dose (RfD) for Captan is 0.13 milligrams per kilogram body weight per day. Therefore, we have:

Safe Consumption = RfD * Body Weight

Safe Consumption = 0.13mg * 62kg (Global Average)

Safe Consumption = 8.06mg per day

Now, if we divide this number by the average concentration, we will be able to find the number of kg of strawberries we are able to consume before the dosage becomes lethal.

kg of Edible Strawberries = Safe Consumption / Average Concentration

kg of Edible Strawberries = 8.06mg / 0.153mg

kg of Edible Strawberries = 52.6 kg

Now, if we look up the number of strawberries in a kilogram of strawberries, we get: around 50 (We will leave it at 50 for this example)

Number of Strawberries = kg of Edible Strawberries * 50

Number of Strawberries = 2634 Strawberries

Conclusion:

As long as you don't consume 2634 strawberries a day, you will not have enough Captan dosage to make it lethal.

Malathion

Now we will start my analyzing Malathion.

```
mala <- usdaNew |>
  filter(Pesticide.Name == "Malathion")
mala
```

	Pesticide.Name	Concentration	EPA.Tolerance..ppm.
1	Malathion	0.0120	8
2	Malathion	0.0084	8
3	Malathion	0.0052	8
4	Malathion	0.0038	8
5	Malathion	0.0050	8
6	Malathion	0.0120	8
7	Malathion	0.0140	8
8	Malathion	0.0020	8
9	Malathion	0.0250	8
10	Malathion	0.0045	8
11	Malathion	0.0065	8
12	Malathion	0.0230	8
13	Malathion	0.0047	8
14	Malathion	0.0046	8
15	Malathion	0.0260	8
16	Malathion	0.0047	8
17	Malathion	0.0380	8
18	Malathion	0.0190	8
19	Malathion	0.0240	8
20	Malathion	0.0062	8
21	Malathion	0.0170	8
22	Malathion	0.0034	8
23	Malathion	0.0110	8
24	Malathion	0.0180	8
25	Malathion	0.0370	8
26	Malathion	0.0420	8
27	Malathion	0.0230	8
28	Malathion	0.0140	8
29	Malathion	0.0360	8
30	Malathion	0.0022	8
31	Malathion	0.0036	8
32	Malathion	0.0120	8
33	Malathion	0.0081	8
34	Malathion	0.0150	8
35	Malathion	0.0140	8
36	Malathion	0.0056	8
37	Malathion	0.0041	8
38	Malathion	0.0130	8
39	Malathion	0.0150	8
40	Malathion	0.0210	8
41	Malathion	0.0230	8
42	Malathion	0.0130	8

43	Malathion	0.0096	8
44	Malathion	0.0300	8
45	Malathion	0.0200	8
46	Malathion	0.0150	8
47	Malathion	0.0037	8
48	Malathion	0.0100	8
49	Malathion	0.0170	8
50	Malathion	0.0220	8
51	Malathion	0.0190	8
52	Malathion	0.0069	8
53	Malathion	0.0058	8
54	Malathion	0.0910	8
55	Malathion	0.0041	8
56	Malathion	0.0100	8
57	Malathion	0.0044	8
58	Malathion	0.0069	8
59	Malathion	0.0470	8
60	Malathion	0.0140	8
61	Malathion	0.0028	8
62	Malathion	0.0079	8
63	Malathion	0.0250	8
64	Malathion	0.0550	8
65	Malathion	0.0240	8
66	Malathion	0.0033	8
67	Malathion	0.0530	8
68	Malathion	0.0290	8
69	Malathion	0.0180	8
70	Malathion	0.0034	8
71	Malathion	0.0230	8
72	Malathion	0.0170	8
73	Malathion	0.0240	8
74	Malathion	0.0260	8
75	Malathion	0.0120	8
76	Malathion	0.0580	8
77	Malathion	0.0160	8
78	Malathion	0.0110	8
79	Malathion	0.0620	8
80	Malathion	0.0270	8
81	Malathion	0.0150	8
82	Malathion	0.0330	8
83	Malathion	0.0038	8
84	Malathion	0.0042	8
85	Malathion	0.0230	8

86	Malathion	0.0370	8
87	Malathion	0.0051	8
88	Malathion	0.0053	8
89	Malathion	0.0140	8
90	Malathion	0.0310	8
91	Malathion	0.0240	8
92	Malathion	0.0069	8
93	Malathion	0.0460	8
94	Malathion	0.0140	8
95	Malathion	0.0440	8
96	Malathion	0.0098	8
97	Malathion	0.0045	8
98	Malathion	0.0190	8
99	Malathion	0.0210	8
100	Malathion	0.0160	8
101	Malathion	0.0240	8
102	Malathion	0.0180	8
103	Malathion	0.0330	8
104	Malathion	0.0430	8
105	Malathion	0.0240	8
106	Malathion	0.0069	8
107	Malathion	0.0021	8
108	Malathion	0.0037	8
109	Malathion	0.0160	8
110	Malathion	0.0022	8
111	Malathion	0.0072	8
112	Malathion	0.0024	8
113	Malathion	0.0035	8
114	Malathion	0.0071	8
115	Malathion	0.0021	8
116	Malathion	0.0064	8
117	Malathion	0.0048	8
118	Malathion	0.0032	8
119	Malathion	0.0040	8
120	Malathion	0.0027	8
121	Malathion	0.0045	8
122	Malathion	0.0027	8
123	Malathion	0.0032	8
124	Malathion	0.0023	8
125	Malathion	0.0045	8
126	Malathion	0.0230	8
127	Malathion	0.0025	8
128	Malathion	0.0110	8

129	Malathion	0.0085	8
130	Malathion	0.0041	8
131	Malathion	0.0060	8
132	Malathion	0.0033	8
133	Malathion	0.0028	8
134	Malathion	0.0021	8
135	Malathion	0.0047	8
136	Malathion	0.0370	8
137	Malathion	0.0084	8
138	Malathion	0.0073	8
139	Malathion	0.0067	8
140	Malathion	0.0061	8
141	Malathion	0.0036	8
142	Malathion	0.0049	8
143	Malathion	0.0048	8
144	Malathion	0.0050	8
145	Malathion	0.0050	8
146	Malathion	0.0052	8
147	Malathion	0.0088	8
148	Malathion	0.0150	8
149	Malathion	0.0045	8
150	Malathion	0.0130	8
151	Malathion	0.0022	8
152	Malathion	0.0023	8
153	Malathion	0.0020	8
154	Malathion	0.0100	8
155	Malathion	0.0039	8
156	Malathion	0.0052	8
157	Malathion	0.0130	8
158	Malathion	0.0048	8
159	Malathion	0.0022	8
160	Malathion	0.0160	8
161	Malathion	0.0034	8
162	Malathion	0.0140	8
163	Malathion	0.0066	8
164	Malathion	0.0046	8
165	Malathion	0.0032	8
166	Malathion	0.0083	8
167	Malathion	0.0023	8
168	Malathion	0.0072	8
169	Malathion	0.0088	8
170	Malathion	0.0035	8
171	Malathion	0.0026	8

172	Malathion	0.0080	8
173	Malathion	0.0027	8
174	Malathion	0.0031	8
175	Malathion	0.0029	8
176	Malathion	0.0024	8
177	Malathion	0.0023	8
178	Malathion	0.0026	8
179	Malathion	0.0036	8
180	Malathion	0.0028	8
181	Malathion	0.0040	8
182	Malathion	0.0089	8
183	Malathion	0.0042	8
184	Malathion	0.0024	8
185	Malathion	0.0030	8
186	Malathion	0.0029	8
187	Malathion	0.0026	8
188	Malathion	0.0130	8
189	Malathion	0.0020	8
190	Malathion	0.0021	8
191	Malathion	0.0043	8
192	Malathion	0.0042	8
193	Malathion	0.0048	8
194	Malathion	0.0057	8
195	Malathion	0.0082	8
196	Malathion	0.0230	8
197	Malathion	0.0230	8
198	Malathion	0.0110	8
199	Malathion	0.0210	8
200	Malathion	0.0160	8
201	Malathion	0.0150	8
202	Malathion	0.0160	8
203	Malathion	0.0560	8
204	Malathion	0.0031	8
205	Malathion	0.0073	8
206	Malathion	0.0063	8
207	Malathion	0.0065	8
208	Malathion	0.0025	8
209	Malathion	0.0020	8
210	Malathion	0.0032	8
211	Malathion	0.0047	8
212	Malathion	0.0026	8
213	Malathion	0.0035	8
214	Malathion	0.0056	8

```
215      Malathion        0.0026                  8
216      Malathion        0.0084                  8
```

Now that we got all of Malathion isolated, we will look at specific values: the Maximum and the Mean.

```
a <- max(mala$Concentration, na.rm = TRUE)
b <- mean(mala$Concentration, na.rm = TRUE)

cat("The maximum value of Malathion concentration in strawberries is:", a)
```

```
The maximum value of Malathion concentration in strawberries is: 0.091
```

```
cat("\nThe average value of Malathion concentration in strawberries is:", b)
```

```
The average value of Malathion concentration in strawberries is: 0.01256898
```

Now from looking up online, the EPA's Reference Dose (RfD) for Malathion is 0.2 milligrams per liter of drinking water per day. Therefore, we have:

Safe Consumption = RfD * Liquid Consumption

Safe Consumption = 0.13mg * 3.7L (Global Average)

Safe Consumption = 0.74mg per day

Now, if we divide this number by the average concentration, we will be able to find the number of kg of strawberries we are able to consume before the dosage becomes lethal.

kg of Edible Strawberries = Safe Consumption / Average Concentration

kg of Edible Strawberries = 0.74mg / 0.0126mg

kg of Edible Strawberries = 58.73kg

Now, if we look up the number of strawberries in a kilogram of strawberries, we get: around 50 (We will leave it at 50 for this example)

Number of Strawberries = kg of Edible Strawberries * 50

Number of Strawberries = 2937 Strawberries

Conclusion:

As long as you don't consume 2937 strawberries a day, you will not have enough Malathion dosage to make it lethal.

Diazinon

There is actually only one case of Diazinon in this data set; therefore, since there is not enough data, I will NOT be testing this pesticide.

Dichlorvos

Now we will start my analyzing Dichlorvos.

```
dich <- usdaNew |>
  filter(Pesticide.Name == "Dichlorvos (DDVP)")
dich
```

```
      Pesticide.Name Concentration EPA.Tolerance..ppm.
1  Dichlorvos (DDVP)         0.099                 1 TP
2  Dichlorvos (DDVP)         0.110                 1 TP
3  Dichlorvos (DDVP)         0.041                 1 TP
4  Dichlorvos (DDVP)         0.026                 1 TP
5  Dichlorvos (DDVP)         0.025                 1 TP
6  Dichlorvos (DDVP)         0.021                 1 TP
7  Dichlorvos (DDVP)         0.030                 1 TP
8  Dichlorvos (DDVP)         0.095                 1 TP
9  Dichlorvos (DDVP)         0.056                 1 TP
10 Dichlorvos (DDVP)         0.028                 1 TP
11 Dichlorvos (DDVP)         0.023                 1 TP
12 Dichlorvos (DDVP)         0.069                    1
13 Dichlorvos (DDVP)         0.032                 1 TP
```

Now that we got all of Dichlorvos isolated, we will look at specific values: the Maximum and the Mean.

```
a <- max(dich$Concentration, na.rm = TRUE)
b <- mean(dich$Concentration, na.rm = TRUE)

cat("The maximum value of Dichlorvos concentration in strawberries is:", a)
```

```
The maximum value of Dichlorvos concentration in strawberries is: 0.11
```

```
cat("\nThe average value of Dichlorvos concentration in strawberries is:", b)
```

```
The average value of Dichlorvos concentration in strawberries is: 0.05038462
```

Now from looking up online, the EPA's Reference Dose (RfD) for Dichlorvos is 0.0005 milligrams per kilogram body weight per day. Therefore, we have:

Safe Consumption = RfD * Liquid Consumption

Safe Consumption = 0.0005mg * 62kg (Global Average)

Safe Consumption = 0.031mg per day

Now, if we divide this number by the average concentration, we will be able to find the number of kg of strawberries we are able to consume before the dosage becomes lethal.

kg of Edible Strawberries = Safe Consumption / Average Concentration

kg of Edible Strawberries = 0.031mg / 0.0504mg

kg of Edible Strawberries = 0.615kg

Now, if we look up the number of strawberries in a kilogram of strawberries, we get: around 50 (We will leave it at 50 for this example)

Number of Strawberries = kg of Edible Strawberries * 50

Number of Strawberries = 31 Strawberries

Conclusion:

As long as you don't consume 31 strawberries a day, you will not have enough Dichlorvos dosage to make it lethal.

However, in this case let's look at the maximum amount of Dichlorvos concentration in a strawberry: 0.11mg. If we were to use this in our calculations, then we would get:

Safe Consumption = RfD * Liquid Consumption

Safe Consumption = 0.0005mg * 62kg (Global Average)

Safe Consumption = 0.031mg per day

kg of Edible Strawberries = Safe Consumption / Average Concentration

kg of Edible Strawberries = 0.031mg / 0.11mg

kg of Edible Strawberries = 0.28kg

Number of Strawberries = kg of Edible Strawberries * 50

Number of Strawberries = 14 Strawberries

Conclusion: If you were to consume even just 14 strawberries of this specific instance of Dichlorvos usage, then it will be enough dosage to be lethal!

Conclusion

It seems that most of the different pesticides that I looked into were safe to consume since you would have to consume almost your body weight of strawberries every single day in order for the dosage to be lethal. The highest food weight intake recorded to date has been only 10.6kg. Therefore there is nothing to worry about.

However, when it Dichlorvos, there needs to be heavy caution due to even only 14 strawberries being consumed can be lethal. I have personally ate 14 strawberries before in one sitting without a problem and I know many of the reader are able to as well. Therefore, this pesticide should be better regulated and monitored for people who will be consuming these strawberries in the future.