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Asian Carp: Toxicology Study

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The idea for a study about Asian Carp initially came about due to my friend and me seeing a relatively comical video on YouTube which showed a carp launching itself out of the water and crashing into someone's face. While this dark humor made us laugh, it also spurred us to do more research into how common this occurrence was. As it turned out, this was not uncommon and other more serious injuries such as broken bones have been reported. This inevitably led to our wondering what people were doing to prevent such a thing from happening in the future and what was being done to control these fish. We quickly learned that these fish were taking over waterways associated with the Mississippi River causing much more damage than a few bloody noses. Wherever these fish went, the local fishing industry was destroyed since Americans tend to dislike eating these relatively bony fish. As a result of this dislike, local authorities have tried to remove these fish from the waterways. This removal process has been done primarily by the use of Rotenone, a powerful piscicide (fish poison) which is highly effective at eliminating fish of all species. After learning that this was the preferred method of removal/control for Asian Carp, we were appalled. My friend, who is Vietnamese, had eaten these fish for much of his life and could not believe that they were being slaughtered instead of harvested. This was the genesis of our project.

After establishing that the invasion of Asian Carp and the reaction to this invasion were worthwhile topics to investigate, it was necessary to decide what needed to be studied in order to confirm the usefulness and viability of *using* these fish rather than killing them. Since it is known that Asian Carp are an acceptable, sustainable food source in Asia, we

wanted to look into the feasibility of commercially harvesting these fish in America and if the widespread poisonings of them would detrimentally affect their usefulness. The results of the feasibility study were that the fish existed in sufficiently large populations and were additionally able to reproduce quickly enough to make commercial harvesting possible. The safety of the fish as a food source became my Engaged Learning project.

First, I determined all of the ways in which the carp were being controlled and how these methods affected the quality of the fish. It became immediately clear that they were controlled almost entirely by the generous use of Rotenone, the pre-mentioned fish poison. This poison is derived from plants and is found naturally occurring in plants such as Cubé, Barbasco, Jewel vine, and a large number of other plants.[1] Other methods of control that did not affect the quality of the fish as a source of food include physical barriers in the form of dams or electrified nodes placed in the water were relatively uncommon and. However, since Rotenone *is* commonly used, it became important to investigate the long term effects of the poison on the environment and especially its effects on carp. To this end, I began collecting all the data on Rotenone that I could find. My sources largely include Extoxnet, a well-known chemical analysis group, and Cornell University along with a published paper by Dr. Kevin C. Ott, Associate Professor of Chemical and Biomolecular Engineering at the University of Nebraska-Lincoln. Another source includes the Arizona game and fish commission.

Next, I wanted to determine the effects of Rotenone so that I could determine if the piscicidal levels of Rotenone would negatively affect people. To this end I found that the quantity of Rotenone needed for use as a piscicide is 20-40 part per billion (ppb).[2] For

[1] http://en.wikipedia.org/wiki/Rotenone#Presence_in_plants

[2] Kevin C. Ott, Rotenone. A Brief Review of its Chemistry, Environmental Fate, and the Toxicity of Rotenone Formulations. http://www.newmexicotu.org/Rotenone%20summary.pdf pg. 2

perspective, a concentration sugar water of this magnitude would be achieved by adding a *teaspoon* of sugar to an Olympic sized swimming pool.[3] This concentration is marvelously small and helped lead to my conclusion that Rotenone does not pose a danger to humans at piscicidal concentrations. Studies conducted by the U.S. Department of Health and Human Services in 1988 on the effects of Rotenone on rats and mice have confirmed that Rotenone does not pose a serious threat to mammals.[4] The effects of Rotenone on humans and mammals have been extensively studied. Studies conducted by Extoxnet have shown that Rotenone is easily excreted from the body and broken down rapidly inside the body.[5] In addition, the liver breaks down Rotenone very effectively. The intestines also do not readily leech the chemical into the bloodstream and the stomach of most animals – including humans – contain enzymes which destroy Rotenone.[6] Since the consumption of this poison does not pose a great threat, consuming fish which have been previously exposed to Rotenone and survived should not pose a problem. Intravenous exposure (direct exposure to bloodstream) is the only way that Rotenone poses a real problem to humans, but this would almost certainly have to be intentional since it would require injecting the chemical into the bloodstream via syringe.[7]

Since Rotenone is not easily absorbed into the body and based on studies by the U.S. Department of Health and Human Services in which rats were fed Rotenone, the "safe level" of Rotenone has been set by the Environmental Protection Agency (EPA) at 40 ppb in drinking water and 90 ppb for casual water contact.[89] The lethal dose for humans at piscicidal

[3] Ibid. pg 2
[4] U.S. Dep. Of Health and Human Services, 1988, http://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr320.pdf pg. 138
[5] Extoxnet, 1996 http://extoxnet.orst.edu/pips/rotenone.htm
[6] ibid
[7] ibid
[8] U.S. Department of Health and Human Services

levels is impossible to achieve. The highest concentrations of Rotenone used for piscicidal reasons are 250 ppb.[10] In order for someone to get a lethal dose they would have to consume 23,000 gallons of treated water in one sitting.[11] This is clearly not possible. In addition, most applications of Rotenone occur at concentrations below 90ppb meaning that people could be safely exposed to treated water immediately after application, according to the EPA.

Levels of Rotenone	Effects on Humans	Effects on other Mammals	Effects on Fish
0 - 40 ppb	none	none	Fairly toxic to most species
40 - 90 ppb	Considered safe for contact	none	Highly toxic to most species
90 – 250 ppb[3]	Considered unsafe[1]	Unknown[2]	Extremely toxic to all species

1. It should be noted that this is based on a 1000 times uncertainty factor from the EPA
2. Effects on all mammals have not been established, but effects are limited for reasons similar to why human are relatively unaffected.
3. Concentrations above 250 ppb are unheard of since the vast majority (if not all) of fish are killed at lower concentrations

Environmental conditions are also an important consideration. Rotenone tends to break down *very* rapidly in the natural environment. This means Rotenone is unlikely to even come in contact with humans, much less poison them. Environmental factors affecting the breakdown of Rotenone include sunlight, heat and water ph.[12] Heat is one factor which has a huge effect on its breakdown. During summer months when water temperatures are high, Rotenone's half-life can be as short as 12 hours with it becoming totally removed after 1 week.[13] Potassium Permanganate can also speed up this process causing it to break down in as little as 30 minutes. This chemical also has a tendency to bond to soil which keeps it from

[9] Arizona State FAQ, http://www.azgfd.gov/h_f/documents/ROTENONE%20FAQ%20committee%20final%20report%20section%201-6-12.pdf pg 3
[10] http://georgina.ca/PDF/goby-fisheries.pdf
[11] Arizona FAQ
[12] ibid
[13] ibid

leeching into groundwater.[14] For these reasons, Rotenone does not pose a serious threat to the general public. In addition, since the chemical does not exist for an extended period of time in the environment, it should be safe to harvest carp after a poisoning if sufficient time has been given to allow the breakdown of the chemical.

Since it has been determined that Rotenone does not pose a serious threat to people, it should be safe to consume these Asian Carp regardless of previous poisonings. Regarding fish which have been killed by a recent poisoning:

> "Calculations that address a worst case situation indicate that a 132 pound person would have to consume 535 pounds of raw fish containing 100 ppb rotenone to acquire a toxic dose. Cooking destroys rotenone so there would be a further loss of any residues during cooking. However, because no tolerance (acceptable residue level permitted in fish flesh) has been set by EPA, the consumption of rotenone killed fish cannot be recommended."[15]

However, as a precaution, harvesting fish in an area where a poisoning has been recently conducted should be limited. Since most fish die from even minor exposure to Rotenone, little is known about how long it takes the chemical to leave their body when they survive exposure. As aforementioned, this should pose little threat to humans since Rotenone is typically only dangerous when taken intravenously.

In conclusion, these carp should be harvested rather than killed for no good reason. This could be a valuable food resource if for nothing other than as an export to Asian countries, not to mention the growing Asian communities already living in the U.S. The populations of Asian Carp are large enough to sustain heavy commercial fishing especially since they have pushed out many of the native species. Heavy commercial fishing could also be another way in which these fish could be controlled. If for no other reason, harvesting

[14] Extoxnet
[15] Oregon Department of Fish and Wildlife
http://www.dfw.state.or.us/fish/local_fisheries/diamond_lake/FAQs.asp

these fish would offset the losses incurred from the reduced numbers of native fish populations. As a final comment, it should be noted that carp tend to require a higher dose of Rotenone to achieve elimination. For this reason, native species will tend to be totally wiped out when carp are targeted. Use of Rotenone as a control should be eliminated in favor of more economically beneficial alternatives.

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