

The Effects of Human Medication on *Lepidium Sativum* & *Raphanus Sativus*

Marianne Querques

Background

Research on animals and humans requires much consideration in regards to ethics, facilities, cost, and time. More than 205,000 drugs are marketed worldwide every year. The current system of drug testing places consumers in a dangerous situation. The fourth leading cause of death in the United States is adverse reaction to prescription drugs. For instance, Evicromila, a drug administered to asthmatics caused liver damage in 20% of clinical trial participants. Accordingly, this raised questions as to whether an alternative to using human or animal test subjects to evaluate the effectiveness of new pharmaceuticals could be found through the use of plants.

Problem (Purpose)

This research experiment explores the effects of human medication, namely ASA, iron, and levothyroxine sodium (LTS) on *Lepidium Sativum* (curly cress) and *Raphanus Sativus* (radishes) to determine whether the use of plants for testing pharmaceuticals is a viable complementary testing method to the experimentation performed on humans and animals.

Hypothesis

It is anticipated the plants will exhibit signs of response to the medication they are exposed to. This will be shown by physical changes to the plant when compared to the control specimen, both macroscopically and microscopically. Macroscopic results, whether positive or negative, will be seen through a change in mass, volume, height, growth rate, and colour. A microscopic analysis will be used to verify macroscopic results by observing the amount of

chlorophyll in the epidermal cells of the stem and leaf, the vascular bundles for structural differences, as well as pith cell and cortex cell wall thickness.

Procedure

Eight separate leca stone beds will be used to hydroponically grow six radish and six curly cress plants per bed as follows:

<i>Leca Stone Bed</i>	<i>Pharmaceutical</i>	<i>Dosage/week</i>	<i>Adult Dosage Equivalent</i>
Control	Not applicable	Nutrient Solution(NS)only	Not applicable
ASA#1	ASA	655.05mg & NS	Maximum daily dosage
ASA#2	ASA	1310.1mg & NS	Double daily dosage
ASA3#	ASA	327.52mg & NS	Half maximum daily dosage
Iron#1	Iron	50.39mg & NS	Maximum daily dosage
Iron#2	Iron	100.78mg & NS	Double daily dosage
LTS#1	LTS	0.17mg & NS	Low maintenance dosage
LTS#2	LTS	0.34mg & NS	High maintenance dosage

Specimen observations will be recorded daily. After the 37th day of experimentation the radishes and cress will be harvested. The specimens will be weighed, measured, and observed under a microscope at the cellular level to identify any physical changes. The dosages of each pharmaceutical were determined using mathematical calculations based on the ratio of the average percentage of water in a human body compared to the amount of water contained in the hydroponic system.

Results/Observations

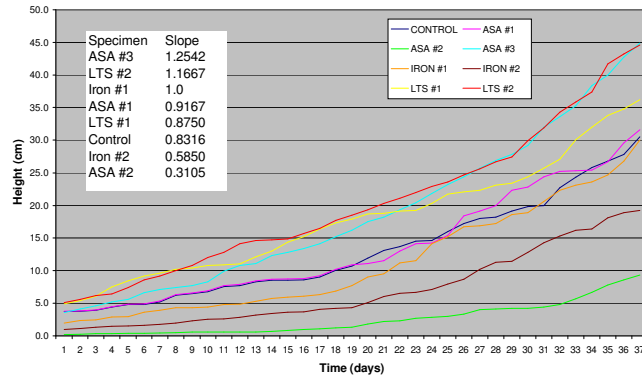
The radishes in the Iron#1 leca stone bed tolerated the pharmaceutical better than the overdose of the Iron#2 specimen. In all categories Iron #1 radishes surpassed Iron #2 radishes as follows; mass was 211.0% greater, volume of the bulb was 284.2% greater, length of the entire plant was 29.4% taller, and the growth rate was 55.6% faster. The radishes in ASA#1, ASA#2

and ASA#3 leca stone beds had inconsistent results. The mass of the entire radish plant was greatest with ASA#2, while the volume of the bulb was greatest with ASA#1, and both the height of the radish plant and growth rate were highest with ASA#3. With respect to LTS #1 and LTS #2 radishes, the LTS #1 maintenance dosage had greater results in all four cases of mass, volume, height, and growth rate. This suggests that dosage does impact the radishes' health, however these results could be due to the effects of the sodium in the LTS, which is added to the medication to make it soluble when ingested. Since the root plays an important role in regulating what nutrients enter the plant, the sodium may have had an impact on the plants exposed to a higher dosage of LTS, especially due to the fact that the radishes' bulb is the primary root in the plant's taproot system. At the microscopic level it was interesting to note the epidermal cells of the radish bulbs in all three ASA specimens were laid out in a uniform arrangement, whereas the rest of the specimens had no discernable pattern. This could mean the LTS and iron had an effect on the radishes' cellular epidermal structure.

The cress results were consistent with all three pharmaceuticals. Iron results showed a clear indication that the maximum dosage level of Iron#1 had consistently greater results; mass at 117.9% greater, height at 35.0% taller, and the growth rate was 69.5% faster than the overdose of Iron#2. When comparing the ASA cress specimens, the ASA#3 low dosage level had the greatest results in all three criteria of mass, length and growth rate, followed by ASA#1 maximum dosage level, and ASA#2 overdose level. The difference between the (low dosage) ASA#3, (maximum dosage)ASA#1, and (overdose)ASA#2 was the cress showed a clear progression of deteriorating tolerance to increased dosage levels. The high maintenance dosage of LTS#2 showed consistently greater results over the low maintenance dosage of LTS #1 in all three criteria of mass, height, and growth rate of 81.7%, 33.1%, and 33.0% respectively. The

cress may not have been as greatly influenced by the presence of the sodium in the LTS. This may be due to cress having a fibrous-root system, and the root structure may not allow the accumulation of sodium in a central area, like that of a tap-root system in the radish. The cress showed consistent growth rate patterns for each of the specimens tested (Figure 2). However, the average growth rates of the radishes were much closer and patterns were more difficult to distinguish as the difference between the slope of each function was small.

Cress Growth Rate Figure 2



Conclusion

From these findings it appears that Iron#1, the maximum dosage of iron allowed, was tolerated by both radish and cress specimens, but an overdose of iron, as in the Iron#2 bed, produced poorer results than the control. This study may have suffered from a false negative or false positive finding. The cress plants appeared to be effected by the varying dosages of medication they were exposed to, but the radish results were inconsistent. When comparing cress and radish results, the conflicting results of the ASA and LTS may indicate results for one of the plant types is inaccurate. If results for the radish specimens were incorrect this would imply a false negative finding, and the medication truly did have an effect on both plants, making them a possible complementary means of testing pharmaceuticals. On the other hand, if results for the cress specimens were inaccurate a false positive may have resulted, and both plants would prove to be unsuitable test subjects in pharmaceutical experimentation.

Based solely on these findings it can be concluded that cress plants are a viable complementary means to test human medication prior to experimentation on animals or humans, and radishes are unsuitable for this type of research. However, there are too many inconsistencies such as quality of seeds, contradictory results between the cress and radish plants, and lack of an adequate microscopic analysis to make these findings absolute.

Acknowledgements

I would like to thank all of the people who have aided me in this project, especially;

- *Dr. A. L. Russell M.D.,M.B.,B.S. Hons., B.Sc. Hons., M.R.C.P. – Qualified Scientist*
- *Dr. S. Yamashiro - Associate Professor-Ontario Veterinary College -University of Guelph*
- *Dr. A. Summerlee – BSc.,BVSc.,PhD.,MRCVS President -University of Guelph*
- *Dr. K. Borkowski –Ph.D., Pharmacology, Vice-President Medical Affairs- AstraZeneca*

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Proof of Requirements

Approvals from recognized institutions and/or scientific mentors were obtained and will be available at the display. The project did not involve human or animal research.

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