Understanding LD_{50} Values

Chemical Safety Demonstration

Introduction

The LD_{50} value is a technical term used to evaluate and define the acute toxicity of a chemical. Demonstrating the quantity of material corresponding to an extrapolated LD_{50} value for humans may help teachers and students understand the relative toxicity of different compounds.

Concepts

- Toxicity
- LD_{50}

Materials

Balance
Beakers, various sizes, 50-mL to 2-L, 6
Graduated cylinders
Sugar or salt (solid)
Water, colored with food dye
Weighing dishes, large, 5

Safety Precautions

Although the materials used in this demonstration are considered nonhazardous, please follow all normal laboratory safety guidelines. Goggles are recommended any time glassware, heat, or chemicals are used in the laboratory.

Procedure

1. Prepare 2 L of colored water in a large beaker or flask using food coloring and tap water.
2. Obtain five large weighing dishes and label them #1–5.
3. Label five beakers, ranging in size from 50-mL to 1-L, #1–5.
4. Weigh the amounts of solid (sugar or salt) corresponding to the extrapolated LD_{50} values for humans (see Table 1) into the appropriate weighing dishes for samples #1–5.
5. Measure out the volumes of colored water corresponding to the extrapolated LD_{50} values for humans (see Table 1) and add the liquids to the appropriate beakers for samples #1–5.

Table 1.

Sample	LD_{50}	Extrapolated LD_{50} for Humans		Example
		Solid[1]	1 M Solution[2]	
1	10 mg/kg	600 mg	3 mL	Arsenic Trioxide
2	100 mg/kg	6 g	30 mL	Barium Chloride
3	300 mg/kg	18 g	90 mL	Copper(II) Sulfate
4	1000 mg/kg	60 g	300 mL	Calcium Chloride
5	3000 mg/kg	180 g	900 mL	Sodium Chloride

1. The extrapolated mass of solid material was calculated assuming a body weight of 60 kg (132 lbs).
2. The extrapolated solution volume was calculated for a 1 M solution assuming a body weight of 60 kg. An average molar mass of 200 g/mole was used to determine the amount of solid in the solution.

6. Discuss the concept of LD_{50} using the solid and liquid samples as a starting point for discussion. The quantity of solid in each weighing dish #1–5 represents the LD_{50} value "translated" or extrapolated to a toxic or lethal dose for humans. Thus, 600 mg of solid would be the toxic dose of a material with an LD_{50} value of 10 mg/kg for a 132-lb person (60 kg).
7. The volume of liquid in each beaker #1–5 represents the toxic or lethal dose for humans if the sample with a given

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LD_{50} value is used in the form of a 1 M solution. Thus, 30 mL would be the toxic dose of a 1 M solution for a substance with an LD_{50} value of 100 mg/kg and a molar mass of 200 g/mole.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Sugar or salt and colored water may be rinsed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Tip

- Remind students that ***no*** quantity of laboratory chemical is ever safe to taste or consume for several reasons. (1) Laboratory chemicals are stored in a chemical storeroom and may become contaminated with small amounts of very toxic chemicals.
  (2) Laboratory chemicals are not produced for human consumption and may contain small amounts of toxic materials that are byproducts in the manufacturing process but do not affect their chemical performance. (3) Some people may have allergic reactions to very small quantities of chemicals.

Discussion

Any substance can be harmful to living organisms. It is the dose, therefore, that frequently determines the extent of the damage. Many factors, including the duration and route of exposure, as well as the age, sex, lifestyle, allergic conditions, previous sensitization, and even genetic predisposition of an individual may impact the overall effect that a chemical has on a person or an organism. Toxicologists have developed many tools to evaluate the toxicity of chemicals. Acute toxicity, which is the immediate effect of a substance as a result of a single dose, is relatively easy to study. Chronic toxicity, resulting from low doses repeated over long periods of time, is much more difficult to test and predict.

One tool or index that toxicologists use to estimate the acute toxicity of a chemical on humans is LD_{50}. The LD_{50} value for a particular substance corresponds to the amount of material that is expected to cause death in half (50%) of a group of some particular animal species when entering the animal's body by a particular route (e.g., by swallowing). LD means the *lethal dose*, 50 means 50% *mortality*, and LD_{50} is normally expressed in milligrams of chemical per kilogram of body weight. The species of the test animal (rats, etc.) and how the substance was administered (oral, inhalation, skin absorption) are usually included in the LD_{50}. A typical toxicology statement might read as follows: Aniline LD_{50} oral-rat: 250 mg/kg. This LD_{50} statement says that a single oral dose of 250 mg of aniline will kill, on average, one-half of a population of 1-kg rats.

It should be noted that no LD_{50} data exists for humans. Data from test animals must be used to estimate the acute toxicity of chemicals on humans. Toxicity data should therefore be used to understand the relative toxicity of various chemicals and which chemicals may require greater precautions when handled. The lower the LD_{50} value, the more toxic the substance. The importance of safe laboratory practice when working with any chemical cannot be over-emphasized. Avoid contact of all chemicals with eyes and skin at all times. Work with volatile chemicals in a hood or well-ventilated lab only. Never inhale or "sniff" any laboratory chemical. Wear chemical splash goggles, chemical-resistant gloves, and chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Always consult current Material Safety Data Sheet to review the properties of a new chemical used in the lab.

Refer to your current *Flinn Scientific Catalog/Reference Manual* for LD_{50} values for common laboratory chemicals.