

DETERMINATION OF THE PHYSICAL PROPERTIES OF DIETARY FIBERS

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BACKGROUND

The National Research Council has recommended increasing the content of dietary fiber in diets for humans. Epidemiological studies have suggested that fiber may be beneficial in reducing diverticular disease and colon cancer. Certain fibers also lower blood lipid levels which may aid in the prevention and/or treatment of atherosclerosis, and they may improve glucose tolerance in diabetics. Mechanisms for the possible effects of fiber are not entirely clear, but may be based upon the ability of various fibers to alter gut transit time or to bind certain compounds such as bile acids.

Dietary fiber is defined as carbohydrate material of plant origin that cannot be digested by the enzymes in the upper gastrointestinal tract and is comprised of such compounds as cellulose, hemicellulose, pectins, and various gums. Some of these materials may in fact be partially digested in the lower gastrointestinal tract by the microbial flora of the colon. Fibers may be soluble or insoluble and have different physiological effects; i.e. cellulose speeds transit of material through the gut while gel-forming fibers may actually retard transit time. Some of the physiological effects of dietary fibers have been attributed to the physical properties of the fibers, such as their solubility in water, acids, and bases, and their tendency to form gels.

The goals of this project are to promote awareness of dietary fiber as a constituent of human diets and to identify the differences in properties among fibers. The project requires close attention to detail and emphasizes an appreciation for the scientific method.

PROBLEM

Determine the physical properties of dietary fibers.

Hypotheses

1. Not all fibers are equally soluble in water, acid, or alkali.
2. Fibers have different tendencies to form gels.

MATERIALS AND METHODS

Cellulose, hemicellulose, pectin, guar, agar and xanthan gum and a balance accurate to .01 g are required. You will also need a safe method for heating the fibers in water, acid,

or alkali. Equipment you should have includes a thermometer, timer, drying oven, filter paper, goggles, beaker and graduated cylinders.

CAUTION: Always add acid to water in making solutions of acid. Do not add water to acid. Wear goggles when working with these solutions.

PROCEDURE

Experiment 1: Determination of solubility at room temperature. Accurately weigh a known amount of each type of fiber (2 g will suffice). Add the fiber to beakers containing 100 ml of distilled water, 1.0 N Sulfuric Acid, or 1.0 N Sodium Hydroxide and stir carefully. Let stand for 24 hours.

Which of the fibers formed gels in which media? Filter the solutions through pre-weighed, dry filter papers and rinse with distilled water. Carefully place filter papers on a tray and dry overnight in a drying oven. Determine the amount of solubility of the fibers by gravimetric analysis (i.e. by weighing).

Experiments 2 and 3: Fiber solubility at 60°C and 100°C. Repeat the experiment above except heat the solutions to 60°C and 100°C gently for 1 hour. Beakers should be covered with watch glasses to prevent loss of solvent or spattering of samples. Electric hot plates or paraffin baths are better suited for this than are bunsen burners. Carefully monitor temperature and watch for signs of gel formation. Determine the amount of solubility by filtering and gravimetric analysis as before.

All experiments should be performed in triplicate and results reported as means \pm standard deviation.

For further consideration: What are your sources of error? Does the concentration of the acid or base make a difference to fiber solubility? For any one fiber, design and perform an experiment to test the effects of acid or base strength on fiber solubility.

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