Soy in Food: What is that doing in there?
Shelf-life extension and preservation
Teacher handout

Description:
This experiment transitions smoothly from the previous exercise which ends with an analysis of the staleness of bread – a quality indicator which signals the end of shelf-life. Stale bread is an indication that moisture has escaped from the product (note that emulsifiers should help retain that moisture). In this lesson, we will be focusing on the microbial spoilage of foods. Food spoilage represents a huge economic burden as up to 40% of food produced is wasted in the U.S. each year. Different processing technologies and formulations have been developed to extend the shelf-life of foods (see also the next lesson on fermented foods). So far, the lessons have been focused on the composition of MACROmolecules in food. Water, a very small molecule, is another important component of all foods and is a significant indicator of shelf-life. Microorganisms which grow in food and cause spoilage are limited if there is not enough water available to support their growth. For this reason, dried foods may often have an extended shelf-life. Water can also be made unavailable to microbes if it is "bound" by ingredients like salt and sugar. For this reason, brined foods may often have an extended shelf-life. In this experiment, students will take different soy-based foods (soy sauce, tofu, and soy flour) and compare how rapidly they spoil. The impact of refrigeration and freezing on microbial growth will also be analyzed. Students will be asked to evaluate different processing and formulation approaches to extend shelf-life by oven drying and salting tofu before initiating their shelf-life study. Students should consider also the limitations of these approaches: sure it extends the shelf-life, but would anyone want to eat this food?

Day 1:
Discussion

- What is food spoilage? How do you know when food is spoiled?
- How do we keep food from spoiling? Suggest some different methods for preservation.
- Gauge students perception on preservatives, how they work and if they're necessary?
- Food spoilage occurs when the product is not longer deemed fit to eat by a consumer. This could result from physiochemical changes, like the stale bread, or microbial spoilage, like moldy bread. Food is preserved through storage in certain environments or containers, processing techniques, or the addition of preservatives. Most preservatives work though specific mechanisms. In this activity you'll be evaluating the role of water in food spoilage.

Activity – Sort products based on shelf-life

- The instructor should provide a variety of foods (can be brought in from home) and scatter around the classroom for students to analyze.
- Students should rank the products from shortest shelf-life to longest. This can be done Price is Right fashion by popular vote of the class.

- Ask students how storage in the refrigerator or on the shelf impacts shelf-life.
- Refer to handout, students should list the product and then determine the predicted shelf-life, listed on the product or by using the USDA's new "FoodSaver" app.
- Students should then determine the predicted water activity for each product using the provided data table.
- Ask students to see if there is a correlation between water activity and shelf life
- Note: water activity is experimentally determined and is a measure of available water (i.e. water which is not bound) in the product. It is reported as a decimal, the ratio between the vapor pressure of water in the product to the vapor pressure of pure water at the same temperature.

Day 2:
Experiment – Set up a shelf-life study

- Students will now perform a qualitative shelf-life analysis of soy-based products
- Split students into teams of three. Each team will be responsible for processing a sample of tofu by drying and with the addition of salt
- Begin with a recap of the findings from the previous day
- Discuss the compositional differences and similarities among soy flour, soy sauce, and tofu
- Have students predict the shelf-life of each of these products
- Randomly assign groups to set up paper plates or cups or baggies containing the three foods, labeled with the start date for the experiment and the temperature at which it is stored.
- For the classroom, make sure each of the three products has at least one sample stored at room temperature, refrigeration, and in the freezer.
- Each team will also be processing the tofu in three ways: oven drying, salting, and salting an oven dried tofu sample.
- Have students set an oven to 150 F. Slice a tofu block and give each group 3 pieces. Try to be consistent with the slicing thickness as this will impact how well it dries in the oven.
- Line baking sheets with parchment paper, place tofu pieces (2/group) to be oven dried on the sheet and bake for 30 minutes to 1 hr. Check regularly to make sure they do not burn.
- For the remaining piece, set out 2 small containers full of salt. Use one container for the un-baked pieces. Use the other container for the oven baked pieces.
- Dredge the pieces in salt and shake to remove excess.
- Transfer all three pieces to a paper plate and label with date, storage condition (room temperature) and treatment (oven dried, salted, salted and oven dried)

Day 3 and on:
Discussion

- Record the day at which the product spoils
- This will vary depending on the classroom conditions and initial product quality

- Stop the exercise based on the spoilage of the tofu. Observable microbial spoilage is unlikely to readily occur in the flour and soy sauce based on dryness and salt levels, respectively.
- Among treated samples, compare the impact of water availability and incubation temperature on the shelf life of products. Which of the samples is the most logical to compare to (which is the control)?
- Can we dry or add to salt to everything? Which of these samples is formulated in such a way that it is still palatable?