DOCUMENT RESUME

ED 141 159 SE 022 681

TITLE The Ocean: Source of Nutrition for the Future. A Learning Experience for Coastal and Oceanic Awareness Studies, No. 305. [Project COAST].
INSTITUTION Delaware Univ., Newark. Coll. of Education.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
PUB DATE 74
NOTE 23p.; For related documents, see SE 022 662-687

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Biological Sciences; *Food; Health; *Instructional Materials; *Natural Resources; Nutrition; *Oceanology; *Secondary Grades; Social Studies; *Teaching Guides; Units of Study
IDENTIFIERS Project COAST

ABSTRACT

The question of future sources of food is posed with increasing frequency as the amount of arable land per person decreases with population growth. The role of the ocean as a food supplier is currently being explored. This learning experience is designed for secondary school students. It is divided into four major areas: (1) an overview, (2) marine plants, (3) fish protein concentrate, and (4) aquaculture. Each of the five lessons is intended for a daily 45-minute class period, but could be modified. (RH)

THE OCEAN: SOURCE OF NUTRITION FOR THE FUTURE

A Learning Experience for
Coastal and Oceanic
Awareness Studies

Produced by

MARINE ENVIRONMENT CURRICULUM STUDY
MARINE ADVISORY SERVICE
UNIVERSITY OF DELAWARE

and

POPULATION-ENVIRONMENT CURRICULUM STUDY
COLLEGE OF EDUCATION
UNIVERSITY OF DELAWARE

as part of a

PLAN FOR ENVIRONMENTAL EDUCATION

Fall 1974

Please send evaluations

of learning experiences

to

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310 Willard Hall Education Building

University of Delaware

Newark, Delaware 19711

Supported in part by

OFFICE OF COASTAL ZONE MANAGEMENT(NOAA)

DELAWARE SEA GRANT COLLEGE PROGRAM(NOAA)

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TITLE: THE OCEAN: SOURCE OF NUTRITION FOR THE FUTURE

* CONCEPT: IV.C.

IV. Cultural evolution led to dominance of the environment.

C. THE GROWTH OF SCIENCE AND TECHNOLOGY INCREASED MAN'S USE OF NATURAL RESOURCES.

** MARINE CONCEPT: 4.12

4. Man is part of the marine ecosystem.

4.1 The marine environment has affected the course of history and the development of human cultures.

4.12 PROXIMITY TO THE OCEANS AND THE AVAILABILITY OF MARINE RESOURCES HAVE INFLUENCED THE CULTURES OF MANY SOCIETIES.

GRADE LEVEL: 9-12

SUBJECTS: Home Economics, Science, Biology, Social Studies

CLASS PERIODS: 5

AUTHORS: Athow, Levitan

INTRODUCTION

The question of future sources of food is posed with increasing frequency as the amount of arable land per person decreases with population growth. The role of the ocean as a food supplier is currently being explored. The ocean has the potential to produce products already in use in greater quantities as well as new products.

This learning experience is divided into four major areas: 1) an overview, 2) marine plants, 3) fish protein concentrate and 4) aquaculture. Each lesson is intended for a daily forty-five minute class period, but may be expanded or condensed depending on time and student interest.

* From A Conceptual Scheme for Population-Environment Studies, 1973. Cost $2.50.

** From Marine Environment Proposed Conceptual Scheme, 1973. No charge.

Both conceptual schemes are available from Robert W. Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

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LESSON I: AN OVERVIEW

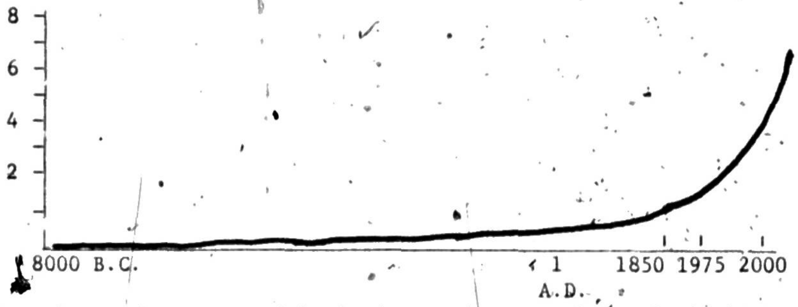
Concept: The world population is growing at a rate faster than present food sources can support. The ocean has many untapped resources for feeding a growing population.

Objectives:

1. To understand the present world food shortage problem.
2. To list possible sources of food from the sea that are rarely or never used today.
3. To taste foods from the sea which may be important sources of nutrition in the future.
4. To overcome psychological barriers to certain foods which students are not accustomed to.

Teacher Background:

From the graph below, it can be seen that it took 1,850 years, from 1 A.D. to 1850, for the population to double from one-half billion to one billion. Demographers predict that the present population of 4.5 billion will increase to 6.5 billion by the year 2000.



In order to keep pace with the increasing annual population rate of three per cent, food production must increase at the rate of four per cent annually. However, present world food production is increasing only 2.7 per cent per annum.

Early man was a hunter, although he also ate berries and seeds. In order to gather enough food for his family, he needed about two square miles of land for hunting. The United States, with an area of 3,600,000 square miles, would only be able to support 1,800,000 families in a hunting society.

About 10,000 years ago, man first started growing crops and raising animals. Thus, he increased his food yield to support the growing population. With experience and technology, man has been able to grow and raise even greater amounts of more nutritious food products. However, the increased food yield from the land is not sufficient to support the present world population.

Since 70 per cent of the earth's surface is covered by water, man is turning more and more to the sea for food resources. However, today he is at the same stage with sea foods that early man was with land foods, i.e., hunting wild stocks of fish and shellfish. In order to increase the yield of food from the sea, man must perform more scientific research, utilize new ocean food sources and begin to "farm" the oceans.

Research has recently begun on increasing the yield of traditional sea foods as well as developing methods for utilizing other sea life. This new field of study in known as aquaculture (agriculture is from the Latin for cultivation of fields; aquaculture is from the Latin for cultivation of water). The Japanese are very advanced in aquaculture because there is so little land to farm in Japan.

Aquaculture efforts include decreasing the growing time of marine organisms, breeding marine organisms to increase number and size, and culturing previously unused resources such as seaweed, algae and other forms of marine life. Alternate forms of sea foods such as fish protein concentrate are also being developed. Foods from the sea include seaweeds, fish and fish products, and shellfish, such as oysters, clams, shrimp and lobsters.

Many people, however, have a psychological barrier against eating many kinds of seafoods, even if they have never tried them before. Since seafoods will be an important source of nutrition, it is important that these barriers be overcome. In this section, a seafood meal will be prepared in an attempt to counter such attitudes.

Learning Experience Procedure:

1. Buzz Session: In groups of three, students should make a list of possible food sources from the sea. (5 minutes)

2. Discuss and compile the buzz session lists. Some possible answers are included in the paragraphs above. The importance of these food resources will be discussed in the following sections of this lesson plan: Marine Plants, Fish Protein Concentrate (FPC) and Aquaculture.

3. Prepare a meal which consists of seafood products that have potential for increased future use:

   Appetizer: Makinori (Japanese seaweed)
   Entree: Oysters, clams, mussels or other fish or shellfish
   Dessert: FPC chocolate chip cookies (see recipe, p. 15)

   For recipes, use a cookbook or the books by Zachary and Steinberg listed in the bibliography. (If the students are not involved in preparing the meal, do not tell them what foods they are eating.)

4. After tasting the foods, have the students complete the exercise "What Food Are You Eating?"

5. Class discussion: List the parts of the meal on the chalkboard. Ask the following for each food tasted and tally the results:

   a. How many liked the dish?
   b. How many disliked the dish?
   c. Was there an unfamiliar flavor in the product?
   d. Can anyone guess what it was?

6. Identify each food item for the class.

7. An excellent introductory movie on the subject is "Food from the Sea," available from Instructional Resources Center, University of Delaware, Newark, DE 19711.

8. Have students write reports on the nutritional value of seafood.

Special Materials Needed:

1. Serving dishes and utensils for a meal.
2. Food items - Japanese seaweed (available at Oriental food stores or health food stores)
   Seafood (available at supermarkets, seafood restaurants, or fish markets)
   Clam juice (available at supermarkets)
   Fish Protein Concentrate (samples available from Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711)
3. Copies of class exercise "What Food Are You Eating?"

Name

What Food Are You Eating?

Try to guess the main ingredients in each of the foods that you have just eaten. Star the ingredients that you think may represent an important part of food production and nutrition in the future.

I. Appetizer

II. Entree

III. Dessert

IV. Beverage

LESSON 2: MARINE PLANTS

Concept: Marine plants and their products are used in many phases of food production. More attention must be given to the greater use of these plants as a direct food source.

Objectives:

1. To understand why the use of plants is important with regard to energy efficiency.
2. To understand the advantages and disadvantages of using various types of marine plants for nutrition.
3. To learn about the present and future uses of marine plants as food sources.

Teacher Background:

The most abundant types of organisms, both on land and in the oceans, are the plants. In the oceans, the majority of these plants are the one-celled algae, which are invisible to the naked eye. These unicellular plants, known as phytoplankton, drift freely throughout the ocean. The more familiar seaweeds are also found throughout the oceans.

Plants are the basis of the food web in the ocean. By photosynthesis, they convert the radiant energy of the sun into organic matter which can then be used as food by the animals of the sea. Usually, small animals eat the plants. The small animals are then eaten by larger ones which are in turn eaten by even larger animals. Each of these links in known as a trophic level. In this manner, the energy of the sun is distributed to all organisms in the form of food.

However, each link in the food chain involves a great loss of energy. It has been estimated that only 10% of the energy is passed from one trophic level to the next. The rest is used to support the activity of the organism or lost as waste material. Thus, there is a greater amount of energy contained in the lower trophic level organisms, especially the plants.

Phytoplankton are very abundant, yet the oceans are so large and the phytoplankton so small that it would be difficult to harvest them. Furthermore, many phytoplankton have a high proportion of indigestible substances and lack certain essential amino acids.

There is one type of algae which appears to be a promising source of food, Chlorella pyrenoidosa. In the mature state, this unicellular plant has a small percentage of protein. But if it is harvested in its early growth stage, it may contain up to 58% protein. The protein contains all the essential amino acids in large quantities and good fat quality. Engineers feel that farm factories which could harvest 20 tons of dry protein and two tons of fat are feasible. But larger marine organisms, which have eaten and stored the energy from the minute food sources, are still a more useful product for man because they are easier to catch.

Seaweeds, on the other hand, are much larger plants that are usually attached to the ocean bottom by means of holdfasts. They have stems and nutrient-absorbing leaves, but no flowers, fruits or tubers. Seaweed presently plays a very small role in world food production. Economically, brown algae (sugar wracks, giant kelp), red algae (Irish moss, dulse laver), and green algae (sea lettuce) are the most important.

In North America, seaweed is used as food in regions near the sea. Because land is scarce, the Japanese use the sea to its fullest extent. They harvest seaweed both from the sea and from algae farms. Laver is the most common variety of seaweed used in Japan and is found in soups, sauces and sushi, a dish containing rice, meat, eggs and fish wrapped in laver leaves. However, laver is a poor source of energy and has a low fat and protein content. But it has a high content of trace elements, minerals, and vitamins, all essential for human growth and development.

Seaweeds are most often used for their extracts. These extracts, agar, carrageenins and algins, contain substances which have excellent gelling properties. They are used to thicken ice cream, soups, sauces, jellies, mayonnaise and sausage casings. Thus, in a single meal, people may eat seaweed in many different forms.

The principal source of algin in the United States is the giant kelp found in large beds off the coast of California. This seaweed is attached to the bottom and rises 165 feet to the surface. It is harvested with the use of barges which cut the weed down to four feet below the surface. The plant is a fast grower, capable of growing two feet in one day or doubling its size in fourteen days. In order to take full advantage of marine plants as a source of nutrition, the harvesting technology must be improved so that large quantities may be obtained inexpensively and efficiently.

Learning Experience Procedure:

1. Lecture-discussion on the uses, advantages, and disadvantages of marine plants as a source of nutrition.
2. Use visual aids to illustrate the ways in which seaweed is used in food. (See bibliography for books and films).
3. Prepare some of the following seaweed dishes. The plants are available from Oriental or health food stores.

Recipes:

Laver Bread (from Wales)

Wash the laver thoroughly to remove any foreign matter. Cook the laver in salted water in copper boiler for twelve hours. Spread the plant and allow to cool. Mince and add food coloring.

To serve, warm in fat or make into small cakes coated with oatmeal and fry.

Sea Cabbage Sauce (from Russia)

Fresh sea cabbage (Laminaria) is cleaned, rinsed and dried. Soak in fresh water for three to four hours. Rinse and chop into small pieces. Fry chopped sea cabbage for five minutes and cool quickly. After tomato sauce is added to a stuffing of sea cabbage, carrots, and beets, the mixture may be canned.

Japanese Use of Laver

Wash the laver in fresh water to remove foreign matter.

Chop leaves up finely and spread out to dry in thin sheets.

This sheet material, known as Asakusa-nori or Hoshi-nori, is then baked or toasted over a fire until the color changes to green.

At this point, several things may be done: it can be broken up and added to sauces or soups; it can be soaked in sauces and eaten; or sushi can be prepared by placing boiled rice and strips of meat or fish on a sheet of hoshi-nori, rolling it up and cutting it into slices.

LESSON 3: FISH PROTEIN CONCENTRATE

Concept: To make more economical use of the total fish catch by processing whole fish into highly nutritional fish protein concentrate (FPC).

Objectives:

1. To understand the need for more efficient processing of whole fish.
2. To evaluate the nutritional contribution of FPC to the diet.
3. To determine the advantages and disadvantages of FPC as a food source.
4. To understand the many ways in which FPC can be used.

Teacher Background

Fish contain very high concentrations of valuable nutrients, especially high-quality protein. However, much of the potential fish yield is not presently being harvested. Furthermore, of the fish that are caught, a large proportion is used as animal feed. Thus the annual yield of fish could be increased while still maintaining a steady stock.

However, certain problems arise with the use of fish as a human food source. First, fish are highly perishable and great precautions must be taken to preserve them. Second, because of people's tastes, only very few species of fish are in much demand. Many species of abundant fish are ignored as a food source. To increase the use of fish as a food source, methods for producing a protein concentrate from fish have been developed.

Fish protein concentrate, or FPC, is a long-lasting product in which the proteins and nutrients are more concentrated than in the fresh fish. The processing methods prevent waste by using whole fish and fish not usually consumed by humans. Depending on the method of processing, the appearance of FPC can range from a tasteless, odorless flour to a fish-flavored, coarse meal or paste.

As seen in Table 1, a commercial FPC, Astra Protein, produced by Nabisco Astra Nutrition Development Corporation, contains 80% protein, with a high concentration of essential amino acids. In vegetable protein, there is a much lower concentration of some of these amino acids. FPC also has a low fat, high (14%) mineral content. It is especially high in calcium and phosphorus.

Table 1. APPROXIMATE ANALYTICAL SPECIFICATIONS FOR ASTRA PROTEIN*

Protein (N x 6.25)	80 %
Fat	0.1%
Water	5 %
Ash	14 %
Calcium	3 %
Phosphorus	2 %
Magnesium	0.3%
Sodium	0.3%
Potassium	0.5%
Chloride	0.2%
Iron	150 ppm
Zinc	120 ppm
Manganese	15 ppm
Copper	6 ppm
Fluorine	80 ppm
Mercury	0.15 ppm
Iodine	0.7 ppm
Residual isopropanol	50 ppm
Total bacterial count	1000/g
Pathogenic bacteria	absent

*There may be variations in protein, ash, and mineral content depending on the species of fish used as a raw material.

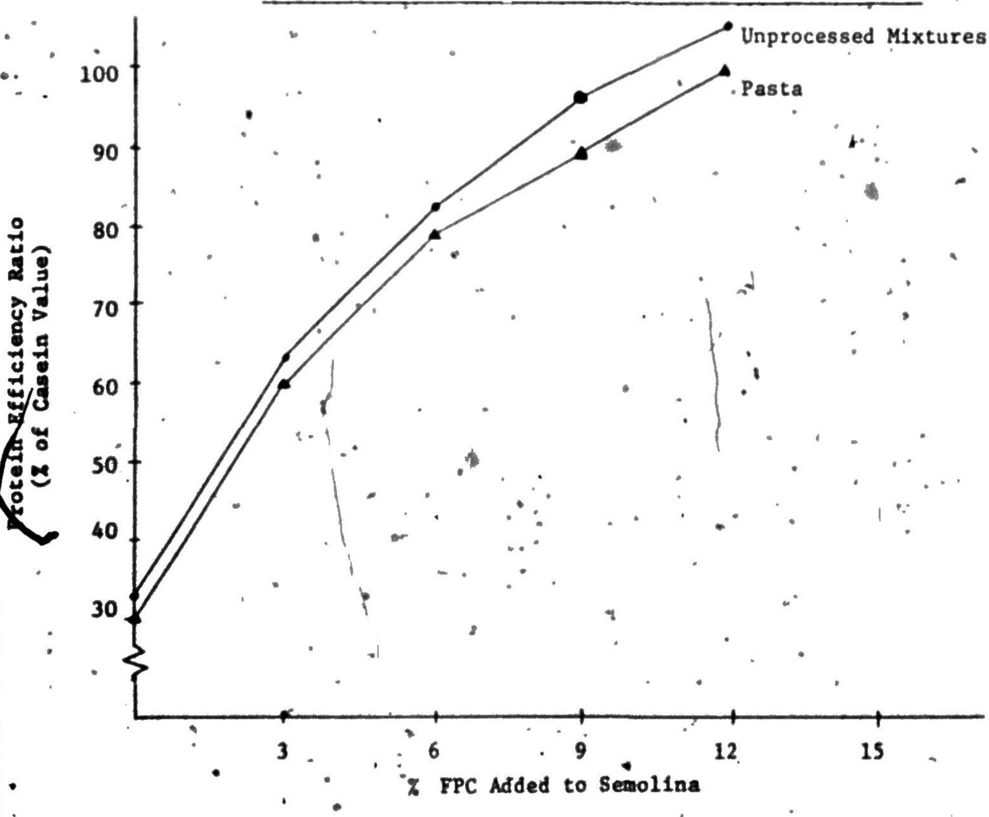
FPC has been designed as a supplement to existing cereal flours such as wheat, corn, oats, rye, rice, millet, sorghum, cassava and soya. It may be used in breads, crackers, pasta noodles, cookies, tortillas and other baked goods. Table 2 and Figure 1 illustrate the increased protein quality when FPC is added to crackers and pasta.

Table 2. QUANTITY AND QUALITY OF PROTEIN IN CRACKERS SUPPLEMENTED WITH FPC

Amount of FPC in crackers	Protein content	Protein quality[1]
0%	9.4%	20%
4%	12.0%	58%
8%	15.3%	77%
12%	17.9%	92%

[1] Protein efficiency ratio values expressed as a percentage of the value for casein.

Figure 1 COMPARISON OF PROTEIN EFFICIENCY RATIOS OF PASTA AND UNPROCESSED MIXTURES OF SEMOLINA AND FPC



When used at optimum amount (10%), FPC has little effect on the taste or character of the foods to which it is added. Also, there is only a slight loss of protein quality during cooking. Protein is a very expensive element of our diet since much of it comes from meat. When flours are fortified with FPC, the cost per unit of usuable protein decreases by 35%.

FPC has proven to be beneficial in supplying nutrition to drought-stricken areas. Because of the continuing need for new sources of food, FPC will have to become a more important food resource for all the countries of the world. However, problems arise from the fact that people are slow to accept new types of food. Also, there is still no large FPC processing industry. With more research and public education, these problems can be overcome.

Learning Experience Procedure:

1. Lecture on the various aspects of FPC. (See Teacher Background.) An excellent background article is "Fish Meal and FPC" by C.P. Idyll, published in the March/April 1973 issue of Sea Frontiers magazine (Vol. 19, #2, p. 83).
2. Discussion of homework assignment (p. 13), especially question 6. These questions may also be used as a discussion guide.
3. Circulate samples of FPC and wheat flour and compare the two as to color, texture, smell and taste. (Samples of FPC are available from Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.)
4. Relate this lesson to others on nutrition by discussing the effects FPC might have on various forms of malnutrition.
5. Recipes using FPC are found on pp. 14-15.

Homework Assignment Answers:

1. Fish are not being harvested to the fullest extent; of those harvested, much is used as animal feed; fish are highly perishable; certain fish are not pleasing to the taste.
2. FPC is a long-lasting fish product of high nutritive quality. Protein and other nutrient materials are more concentrated than in fresh fish.
3. High protein and mineral content; low fat content.
4. Bread, crackers, noodles, cookies, tortillas.
5. When used in its optimum amount (10%), FPC alters the physical and sensory characteristics very little.
6. Advantages:

   a. makes very efficient use of a catch of fish by using all parts
   b. very high in protein (80%) and very low in fat (0.1%)
   c. easily used as a food supplement without loss of nutritive value
   d. does not alter the taste or character of food
   e. since fish are abundant, FPC is abundant
   f. it can be stored for long periods of time

   Disadvantages:

   a. people are slow to accept new types of food
   b. there is still no large FPC processing industry

Homework Assignment:

From the class lecture, answer the following questions. Be able to discuss your answers in class.

1. Why are fish not used to their full potential as a human food source?

2. What is fish protein concentrate?

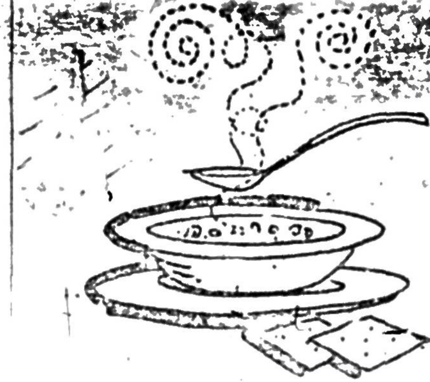
3. List two properties of FPC which indicate it could alleviate malnutrition in an acceptable way.

4. What products lend themselves well to the addition of FPC?

5. Do any changes in the taste or texture of foods occur when FPC is used in their preparation?

6. Discuss your thoughts on the advantages and disadvantages of using FPC extensively in food production.

Fish protein concentrate (FPC) is an excellent source of high quality, low cost animal protein. It can be used in foods to improve the quality and increase the quantity of protein. A mixture of nine parts of wheat flour and one part of FPC is three to four times more nutritious than just wheat flour alone. Such a mixture can be used to prepare foods – such as bread and cookies – that are excellent in quality and most acceptable.



FPC can be used in soups. In the following recipe FPC is used to make light, fluffy dumplings.

HEARTY SOUP

- 1 tablespoon butter
- 1/2 cup flour/FPC mixture (8 parts flour to 1 part FPC)
- 1/4 teaspoon baking powder
- 1 egg
- 1 tablespoon parmesan cheese
- 6 cups of chicken broth
- 1/3 cup of tomato sauce

Melt butter. Add flour and baking powder. Mix well. Add egg. Beat well *after each addition*. Blend in cheese. Heat broth and tomato sauce to boiling. Drop mixture into the hot broth by 1/2 teaspoon at a time. Cover lightly. Cook for 10 minutes.

Industry can very effectively use FPC to fortify many of the cereal products, like bread, pasta (macaroni products), crackers, and cookies. The bread fortified with FPC is equally as good as the non-fortified bread in texture and flavor, but slightly tannish in color. Experiments have shown the following formulation can be used to make excellent bread.

Flour	700 grams
	Percent of the flour
FPC	10
Sugar	8
Salt	2
Yeast food	.5
Yeast (dry)	2.5
Fat	2
Water	66

Dissolve yeast and yeast food in some warm water (90°-95°F). Stir. In the mixer, place about half (50-60 percent) of the flour, half of the water, and the dissolved yeast. Mix for about five minutes.

Place in the fermentor for four hours at 80°-85°F.

At the end of the four hours, take the remaining ingredients – sugar, salt, fat, remaining flour and FPC – and place in the mixer. Mix for several minutes or until the FPC is well mixed with the other ingredients. Add the remaining water. Mix for several minutes (one to two). Add the sponge. Mix until dough has developed, about seven to eight minutes.

Weigh the dough (518 grams) and allow to relax for ten to fifteen minutes.

Sheet and mold the dough. Place in pans. Place pans in proofing cabinet at 90°F and 90 percent humidity until the dough has risen to one-half inch above the sides of the pan (50-60 minutes).

Bake at 420°F for 20-25 minutes.

FPC can be incorporated into pasta (macaroni products) to make *a more nutritious product*. Make a mixture of 92 percent semolina and 8 percent FPC. Then follow the usual procedure in the making of pasta. The only difference will be in the amount of water needed to prepare the dough. A little more water is needed with each percent increment of FPC. The dough will go through the extruder quite easily.

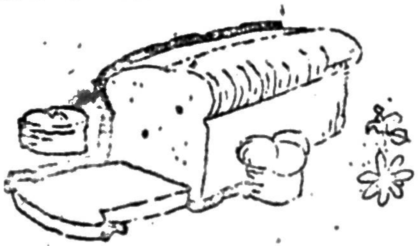
A very acceptable and nutritious cracker, cookie, or snack can be made by replacing 8 to 10 percent of the flour with FPC. When FPC is used milk is not needed. Replace the usual amount of liquid milk with water. Chances are a little more water will be needed than the amount listed in the formulation. With a little experimentation, the adjustments can be made.

IV.C. (Mar. 4.12) p. 16

The following FPC-wheat flour mixture can be made at home and used in recipes:

4-1/2 pounds (or 18 cups) of all-purpose flour
1/2 pound (or 2 cups) of FPC

Mix the all-purpose flour and the FPC, sift several times and store in an airtight container. This supplemented wheat flour mixture can then be used in the recipes that are given below or in other recipes that require wheat flour.



BREAD

- 5 cups lukewarm water (110° - 115° F.)
- 1/2 cup sugar
- 2 packages active dry yeast
- 14 cups (about) sifted FPC flour
- 1/3 cup shortening
- 2 tablespoons salt

Combine 3 cups water, 1/4 cup sugar and sprinkle yeast over top; mix. Let stand until yeast is dissolved. Stir in 4 cups FPC flour; beat until smooth. Cover with towel and let rise in warm draftless area until light and spongy, about 1 hour. Heat remaining 2 cups water; stir in shortening, remaining 1/4 cup sugar and salt. Allow shortening to melt; cool to lukewarm. Stir yeast mixture to break bubbles; add to lukewarm water. Stir in remaining 10 cups FPC flour or flour needed to make a soft dough. Turn onto lightly floured board. Knead until dough is "springy." Press finger into dough. If dough springs back it is considered "springy." Place in large well greased bowl; turn dough over to grease both sides. Cover with towel. Set in warm draftless area until dough doubles in size, about 1-1/2 hours. Punch dough down with fist. Turn onto lightly floured board; divide into 3 equal portions; cover and let rest 8 to 10 minutes. Shape pieces of dough into loaves 9 inches long. Place each in a greased 9 x 5 x 3 inch loaf pan pressing loaf to one long edge of pan. Cover with towel or plastic film. Place in warm draftless area until double in size. Bake in center (be careful pans do not touch) of moderate oven, 350°F. Bake until done, 40 to 45 minutes. To test for doneness tap loaf gently with finger. Loaf will sound hollow if done. Remove from pans at once and cool on wire rack. Makes three 9 x 5 x 4-1/2 inch loaves.

FPC – CINNAMON COOKIES

- 1/2 cup vegetable shortening
- 1/2 cup butter or margarine
- 1-3/4 cups sugar
- 2 eggs
- 2-3/4 cups sifted FPC-flour
- 2 teaspoons cream of tartar
- 1 teaspoon soda
- 3/4 teaspoon salt
- 2 teaspoons cinnamon

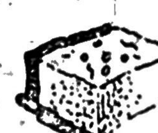
Mix shortening, butter, 1-1/2 cups sugar and eggs thoroughly. Combine and sift flour mixture, cream of tartar, soda and salt. Stir dry ingredients into shortening-sugar mixture. Chill 1 hour. While dough is chilling mix remaining 1/4 cup sugar and cinnamon. Shape rounded tablespoonfuls of dough into balls. Roll balls in cinnamon sugar. Place 2 inches apart on ungreased baking sheets. Bake in moderate oven, 350°F. about 10 minutes or until done and lightly browned. Cookies will puff up then flatten. Remove from baking sheet and cool on racks. Makes about 40 2-1/2 to 3-inch cookies.

FPC – CHOCOLATE CHIP COOKIES

- 2-3/4 cups sifted FPC-flour
- 1 teaspoon soda
- 1 teaspoon salt
- 1 cup butter or margarine
- 3/4 cup brown sugar
- 3/4 cup granulated sugar
- 2 eggs
- 1-1/2 teaspoons vanilla
- 2 packages (6 ounce) chocolate chips
- 1/2 cup chopped pecans, if desired

Combine and sift first 3 ingredients; reserve. Cream butter or margarine, sugars, eggs and vanilla until smooth and fluffy. Stir dry ingredients into creamed mixture. Add chocolate chips and nuts; mix well. Drop level tablespoons of dough 2 inches apart on ungreased baking sheet. Bake in moderate oven, 375°F., about 10 minutes or until done and a golden brown. Remove cookies from baking sheet and cool on racks. Makes about 72 2-inch cookies.

RUM TORTE



- 4 eggs, separated
- 1/2 cup sugar
- 1/4 teaspoon salt
- 1-1/2 teaspoons vanilla
- 1 cup FPC-flour
- 1/3 cup melted butter

Sauce and Topping

- 1-1/2 cups sugar
- 1-1/2 cups water
- 1/2 cup brandy, rum, sherry or orange juice
- 2 teaspoons grated orange rind
- 1/4 cup flaked coconut or chopped nuts or mixture of both

Beat egg whites until they form soft peaks. Gradually add 1/4 cup sugar to egg whites beating constantly until egg whites are stiff and glossy. Beat egg yolks, remaining sugar, salt and vanilla until thick. Fold into egg whites. Fold in dry ingredients, then butter. Pour into 2 quart casserole. Bake in moderate oven, 350°F., until done and lightly browned, (about 30 minutes.) Prepare sauce while cake is baking. Combine sugar and water; cook to soft ball stage, 246°F. Add liquor or orange juice and rind. Poke holes all over cake from top to bottom using a skewer or ice pick. Pour sauce over cake. Before liquid is all absorbed sprinkle top with coconut or chopped nuts or a combination of both. Serve warm. Makes 8 servings.

APPLE-NUT BARS

- 1 cup sifted FPC flour
- 1/4 teaspoon baking powder
- 1/2 teaspoon salt
- 1/4 cup butter or margarine (melted)
- 1 cup granulated sugar
- 2 eggs (well beaten)
- 1 cup chopped nuts
- 1/3 cup raisins
- 2/3 cups finely-cut dried apples
- Confectioner's sugar

Sift dry ingredients into bowl. Add remaining ingredients except confectioner's sugar. Mix well and pour into buttered pan (13 x 9 x 2 inches). Bake in preheated oven (350°F.) for about 25 minutes. While still warm, cut into 27 bars, 3 x 1-1/2 inches. Roll in confectioner's sugar.

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LESSON 4: AQUACULTURE

Concept: Through the widespread practice of aquaculture, the yield of marine organisms can be substantially increased to provide nutrition for a larger number of people.

Objectives:

1. To establish possible advantages and disadvantages of increasing food production through aquaculture.
2. To determine what organisms can be "farmed" and the methods involved.
3. To assess the nutritional value of aquacultural products.

Teacher Background:

Acre for acre, the sea can be just as productive as the land, especially in near-shore regions. As opposed to the land, however, man still gets most of his food from the sea by hunting. In many cases, this method is inefficient. But now, man is beginning to realize the advantages of aquaculture--farming the aquatic environment.

Presently, there are four basic types of aquaculture. The first is the hatchery in which large numbers of young are raised in controlled areas. They are then released into their natural setting where it's expected the population of that species will increase. This technique has been successful in the United States with members of the salmon family. Overall, however, hatcheries have been unsuccessful because the fish, when released, are unable to fend for themselves. Furthermore, the numbers released do not add significantly to the existing natural population.

The second type involves capture and impoundment of the young. In this way, more food may be provided. The third type of aquaculture is the raising of marine organisms from youth until they reach marketable size. The final and most difficult method involves full control of the life cycle and closely approximates land farming. Eggs are hatched and the various life stages are raised and fed until marketing. Also, a brood stock is maintained to provide more eggs.

The criteria for successful aquaculture limits the number of marine animals which may be used; The organism should be: 1) capable of being raised easily from the egg; 2) fast-growing; 3) able to eat inexpensive and abundant food, preferably plants; and 4) resistant to disease and unfavorable environmental conditions. Thus many open sea fishes which require large amounts of space and food are not suitable for culturing. However, many of these fish schools can, with proper management, be caught efficiently year after year.

Oysters have been the most successfully farmed marine organism. They are attached animals, live in shallow, brackish waters, produce large numbers of eggs and feed on plants. The oyster larvae swim for a couple of weeks. They then settle on a hard surface as spat, whereupon they develop into the adult. In oyster culturing, hard surfaces are provided for spat settling. During development, spat are separated to prevent crowding. The growing adults are often cleaned of algae which may inhibit their filtering apparatus. Also, oyster predators such as starfish and oyster drills are controlled. Mussels are cultivated in a similar manner.

Other more sophisticated and scientific techniques for raising oysters have been developed. At the University of Delaware, clams and oysters have been raised in a closed system from egg to adult at a much faster rate than in natural situations. In a closed system, the water is recirculated so that there is no dependence on natural waters. In this way, it is possible to raise marine organisms at locations away from the marine environment.

In Japan, methods for harvesting shrimp have been successfully developed. Gravid females are placed in spawning tanks where each releases 200,000 eggs. As the shrimp larvae grow, their appetites grow and their tastes change. The post-larval shrimp are then transferred to outdoor rearing ponds where they eventually develop into adults. By controlling type and amount of food, predators and parasites, water quality and its oxygen content, shrimp can be grown larger in a shorter amount of time than they grow in the natural environment. Other crustaceans for which culturing methods are being developed are lobsters and crabs.

Many fish are reared in fresh and salt water ponds. Plant-eating fish are the most advantageous because of the low food cost and high energy efficiency. An excellent example is the herring-like milkfish, cultured in the Far East. These fish are reared in a similar manner as the shrimp. Different life stages are reared in different ponds and their environments are closely controlled at all times.

There are still many man-made obstacles impeding the progress of aquaculture. Shore regions are needed in many methods of aquaculture. However, this land is in high demand by recreationists, developers and industrialists. Thus the high costs may act as a deterrent. The greatest threat to the aquaculture industry is pollution. Sewage, industrial wastes, pesticides and radioactivity all affect marine organisms and thus affect aquaculture.

Learning Experience Procedure:

1. Lecture-discussion on the various aspects of aquaculture as described in the Teacher Background.

2. Discuss the following topics:
   a. advantages and benefits of aquaculture
   b. problems to be overcome in the development of aquaculture

3. Individual reports: Have students report on the ways in which a particular marine organism is or can be harvested. These reports should include something about the organism's life cycle. The organisms may include plants (seaweeds), fish, mollusks, crustaceans, plankton and marine mammals.

4. Guest speaker: Arrange to have speaker talk about aquaculture. Contact your state division of fish and wildlife or a university marine extension agent.

5. Suggested film: "Take Two from the Sea." Gives description of harvesting, culturing, processing, cooking and serving of oysters and clams. Free film which should be booked three months in advance from:

   National Oceanic and Atmospheric Administration
   U.S. Department of Commerce
   Motion Picture Section
   12231 Wilkens Avenue
   Rockville, MD 20852

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Appreciation is extended to Dr. Bruce R. Stillings of Nabisco Astra Nutrition Development Corporation for his assistance in the preparation of this learning experience.