## Chapter 9: Fats & Oils

# FATTY DISTINCTION

## Did you know that fat is added to many foods?

There are many functions of fat depending upon the type. Butter and margarine are examples of fats that are solid at room temperature. Cooking oils, such as olive oil or vegetable oil, are examples of fats that are liquid at room temperature. Fats that are solid at room temperature have higher ***melting points***, meaning more heat is needed to melt the solid fat into a liquid. The exact temperature at which a solid fat becomes a liquid is considered the melting point.

Fats are also known as fatty acids. Fatty acids are categorized as saturated or unsaturated based on their chemical structure. ***Saturated fats*** hold all the hydrogen bonds that can be attached to the carbon. In other words, the hydrogen molecules are "saturated" with carbon molecules. ***Unsaturated fats*** contain double bonds between the carbons instead of being saturated with hydrogen. ***Trans fats*** are unsaturated fatty acids that have been turned into saturated fatty acids by breaking the double bond between the carbon atoms and forcing hydrogen atoms on to the carbon atoms. This conversion allows liquids to become solid at room temperature, creating fats like margarine. This transformation also results in a higher melting point.

Unsaturated fats are beneficial for our body. They help protect our heart by increasing good cholesterol and decreasing bad cholesterol. Foods like almonds, salmon, and avocados are high in these healthy fats. Trans fats have the opposite effect on health. You will learn more about saturated and unsaturated fats in *Food Explorations Lab I* of this chapter.

Fats can also be used in mixtures. There are two main types of mixtures: homogeneous and heterogeneous. ***Homogeneous*** mixtures are the same throughout and have a uniform appearance (e.g. milk), while ***heterogeneous*** mixtures are not the same throughout. They have more than one color, substance, or texture visible. Fat emulsions are considered a heterogeneous mixture. An ***emulsion*** is a mixture of two liquids that won't mix together homogenously (oil and water) on their own without an emulsifier added. When a fat is mixed with an emulsifier, like eggs, the fat and water and are able to mix to form a uniform liquid. Salad dressings and mayonnaise are the most common types of emulsions we eat. You will learn more about emulsions in *Food Explorations Lab II* of this chapter.

*Depending on the melting point, a fat can be liquid or solid at room temperature.*

Even though consuming too much fat is not considered healthy, it is important to consume adequate amounts of fat in our diet. Our bodies need fat for energy, nerve and brain function, and growth; however, we still need to be careful about the types and amounts of fat we choose to consume. You should choose to eat foods that are high in unsaturated fats and moderate in saturated fatty acids. If possible, you should eliminate trans fat from your diet. Newer food production technologies have been created to help reduce the level of trans fats in many foods. Avoiding overconsumption of these foods will help decrease our risk for diet-related diseases such as heart disease, stroke, overweight/obesity, and Type 2 Diabetes. Let's explore the many functions of fat!

# Think About It

## Food Explorations Lab I

1. Unsaturated fats contain double bonds between carbon atoms.

2. Saturated and trans fats have higher melting points than unsaturated fats.

## Food Explorations Lab II

1. A mixture of oil and water is heterogeneous (heterogeneous/homogeneous).

2. An emulsion is a homogeneous (heterogeneous/homogeneous) mixture.

3. A(n) emulsifier must be added to a mixture to make it uniform.

# Food Explorations Lab I:
# Lipid Language

**STUDENT LAB INVESTIGATIONS**

**Name:** _____

## Lab Overview

In this investigation, you will record observations involving the melting and solidifying of different types of fat (margarine, butter, and vegetable oil).

## Lab Objectives

*In this lab, you will learn how to…*

1. Observe physical properties of dietary fats and the physical changes occurring in dietary fats during temperature changes.
2. Use measured melting and solidifying temperatures to determine the relative amounts of saturated and unsaturated fats present in different types of fat.
3. Identify dietary fat that is beneficial to the body's health.
4. Identify dietary fat that can be harmful to the body's health.

**Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following the completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.**

# Observation of Lipid Properties Under Varying Temperatures

## Lab Question

Which type of fat (margarine or butter) will melt faster? Which type of fat (margarine, butter, or vegetable oil) will solidify the fastest? (Circle your answers.)

**Predictions:** The _____ will melt faster because…

and the _____ will solidify faster because…

## MATERIALS

1 small bowl
1 small, clear plastic cup containing ¼ cup of assigned fat type
Stopwatch or kitchen timer
2 cups ice
1 thermometer

Obtain your fat assignment from your teacher. Record your group's assignment (butter, margarine, or oil) below.

**My group's fat type is: _____**

## PROCEDURE

Describe your *visual* observations of each fat type before treatment. Record your observations in Table A under the column labeled "Observation BEFORE Treatments."

## Heat Treatment

1. Your teacher will demonstrate how to find the melting points of butter and margarine. Oil will not undergo heat treatment, because it is already a liquid at room temperature.
2. Your teacher will add ½ cup of cold butter to a saucepan and add ½ cup of cold margarine to a saucepan.
3. Your teacher will heat each fat type on medium heat until each fat has completely melted.
4. Use the stopwatch to find the amount of time (minutes:seconds) it takes to melt each fat type and record the time in Table B under the column labeled "Heat Treatment."
5. Your teacher will measure the temperature of each melted fat type. Record the temperature of each fat in Table B under the column labeled "Heat Treatment."
6. Describe your *visual* observations of each melted fat type after heat treatment. Record your observations in Table B under the column labeled "Observations."
7. Your teacher will pour ¼ cup of each melted fat type into a separate plastic cup to be used for cold treatment.

## Cold Treatment

1. Obtain ¼ cup of your assigned fat type in a plastic cup. All fats should be in liquid form.
2. Obtain ice in your small bowl from your teacher.
3. Place the cup containing the liquid fat in the bowl and surround with the ice.

   Use the stopwatch to determine how long it takes your liquid fat type to solidify. Lift your cup periodically to look for solidification on the bottom. The oil will not solidify like butter and margarine. Instead, look for a cloudy appearance to indicate solidification.

4. Record the time it takes for your fat type to solidify in Table C under the column "Cold Treatment."
5. Note the temperature of your fat type once it completely solidifies. Record the temperature in Table C under the column "Cold Treatment."
6. Describe your *visual* observations of your assigned fat type **after** cold treatment. Record your observations in Table C under the column labeled "Observations."
7. Share your findings with other groups. Be sure to record observations and data missing from your tables for the fat types not assigned to your group.

**Table A: Fat Observations Before Treatments**

| Substance | Observations BEFORE Treatment |
|---|---|
| Butter | A little bit of foam<br>Solid at room temperature Yellow and smooth |
| Margarine | No foam<br>Solid at room temperature Yellow and smooth |
| Oil | Almost clear with a yellow tint<br>Liquid at room temperature |

**Table B: Fat Heat Treatment and Observations**

| Substance | Heat Treatment<br>(Time to Melt and Temperature) | Observations |
|---|---|---|
| Butter | **Total Time:** 4:25<br>**Final Temperature (Melting Point):**<br>~170°F<br>(77°C) | |
| Margarine | **Total Time:** 3:15<br>**Final Temperature (Melting Point):**<br>~204°F<br>(96°C) | |

**TEACHER'S NOTE:** Numbers in the tables above are estimates only. The values students obtain will vary.

**Table C: Fat Cold Treatment and Observations**

| Substance | Cold Treatment (Time to solidify and Temperature) | Observations |
|---|---|---|
| **Butter** | **Total Time:** 4:00<br>**Final Temperature:** ~ 64°F (18°C) | Solidified on bottom with a little bit of liquid on top. Solidified more than margarine. |
| **Margarine** | **Total Time:** 2:30<br>**Final Temperature:** 70°F (24°C) | Some solidification on the bottom, but mostly liquid. |
| **Oil** | **Total Time:** 6:15<br>**Final Temperature:** 60°F (16°C) | Did not show signs of solidification. |

**TEACHER'S NOTE:** Numbers in the tables above are estimates only. Students' values will vary.

## Conclusion:

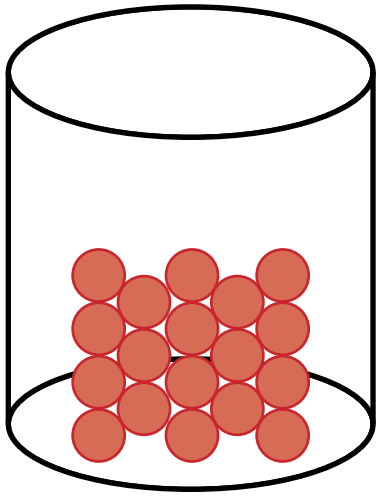
1. Which fat type melted at the lowest temperature? Which fat type solidified at the highest temperature? Referring to the reading "Fatty Distinction", explain the results observed.

   Butter melted at the lowest temperature. Margarine solidified at the highest temperature because it has less saturated fat than butter.

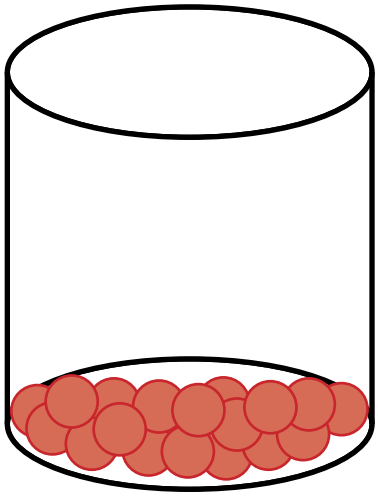
2. Explain how the motion of the fat molecules (particles) is affected as temperature increases and as temperature decreases.

   The fat molecules began to spread apart and move faster when they were being heated. When the fat molecules were being cooled, they move more slowly and closer together.

3. Draw a diagram illustrating the difference between the fat molecules in a solid state versus in the liquid state.



**Fat Molecules in Solid State**



**Fat Molecules in Liquid State**

4. Explain which fat type contains the largest amount of saturated fat molecules and which contains the least. Support your answer using data from the investigation.

Butter contains the largest amount of saturated fat because it has the highest melting point and is made from animal sources. Vegetable oil contains the least saturated fat because it is liquid at room temperature.

5. Explain which fat type contains the largest amount of unsaturated fat molecules and which contains the least. Support your answer using data from the investigation.

Vegetable oil contains the largest amount unsaturated fat because it is liquid at room temperature.

Butter contains the least amount of unsaturated fat because it has the highest melting point.

6. Based on the reading and your observations, identify which type of dietary fat is the healthiest for your body and explain why.

   Unsaturated fat (liquid at room temperature) is the healthiest for my body because it does not raise cholesterol levels.

7. Identify the type of fat that might cause the most health problems for a person's circulatory system and explain why.

   Eating saturated fat prevents you from eating unsaturated fat that is healthier.

## Food Explorations Lab II:

# Examining Emulsions

**STUDENT LAB INVESTIGATIONS**

**Name:** _____

## Lab Overview

In this investigation, you will add substances to oil and water to determine which one(s) will act as an emulsifier to form a homogeneous solution.

## Lab Objectives:

*In this lab, you will learn how to…*

1. Observe physical changes occurring when substances are added to a heterogeneous lipid mixture.

2. Identify and distinguish between homogeneous and heterogeneous mixtures.

3. Relate the structure of a cell membrane to the observed properties of a lipid mixture.

**Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following the completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.**

## Lab Question

Which of the following substances has the ability to act as an emulsifier? (Circle your answer.)

Salt  Ground Mustard  Honey  Paprika

**Predictions:** I predict _____will allow vinegar (water) and oil to mix because…

## MATERIALS

5 medium mason jars
⅝ cups olive oil
1 teaspoon honey
1 teaspoon salt
1 set of measuring spoons
1 black maker
1 kitchen timer or stopwatch
1 whisk
6 plastic forks
⅝ cups white vinegar
1 teaspoon ground mustard
1 teaspoon paprika
1 large bowl
1 liquid measuring cup
5 labels
6 paper plates
fresh romaine lettuce

## PROCEDURE

1. Prepare your Mason jars by measuring ⅛ cup vinegar and ⅛ cup olive oil to each jar.

2. Label each of your jars with 1 of the following: "Control" (vinegar and oil only), "Salt", "Mustard", Honey", and "Paprika".

3. Once your vinegar and oil samples have been prepared, you are ready to begin. Draw your *visual* observation of the vinegar and oil mixture in Table A.

4. Add 1 teaspoon of each substance (ground mustard, honey, paprika, and salt) to their labeled jars. For instance, you should add 1 teaspoon of salt to the jar containing vinegar and oil that is labeled "salt".

5. Put lids on the jars tightly. With all group members participating, shake the jars vigorously for about 30 seconds.

6. Set your kitchen timer for 10 minutes. Observe the contents of each jar as time passes. Use the stopwatch to help determine how long it takes for each mixture to separate and record the time in Table B.

   **NOTE:** Not all mixtures will separate due to the presence of an emulsifier.

7. Draw your observations of each mixture **after 3 minutes** have passed in Table C. Label the oil and vinegar layers on the drawings of the mixtures that have separated.

8. After you have completed your observations and conclusion, wash your hands.

9. Make observations as you combine the contents from 4 jars (vinegar/oil, ground mustard, honey, paprika), and ½ of the salt jar into 1 large bowl, and as you use a whisk and mix together the ingredients.

10. You have made vinaigrette! Taste your vinaigrette with fresh romaine lettuce.

**Table A: Emulsion Observations Before Treatment**

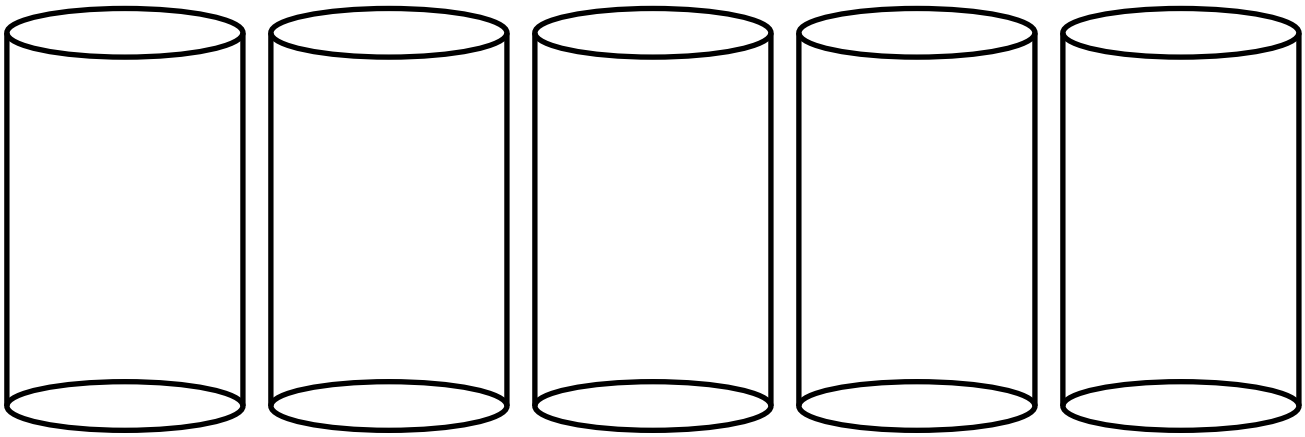
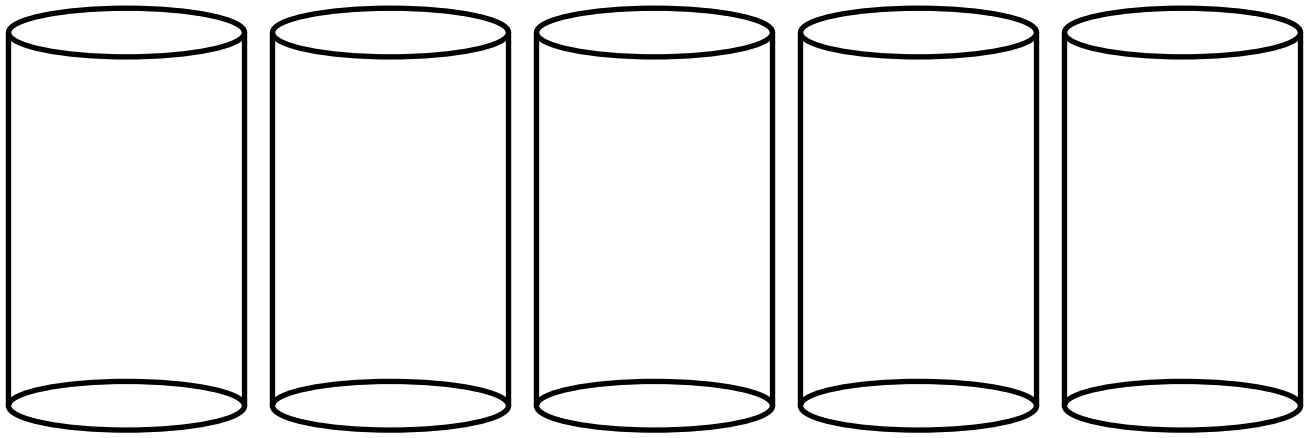
| BEFORE TREATMENT | | | | |
|---|---|---|---|---|
|  | | | | |
| **Vinegar & Oil** (Control) | **Salt** | **Ground Mustard** | **Honey** | **Paprika** |

**Table B: Emulsion Treatment Observations**

| | Vinegar & Oil (Control) | Ground Mustard | Honey | Paprika | Salt |
|---|---|---|---|---|---|
| **Length Time to Separate** (Minutes and Seconds) | Almost immediately (within 10 seconds) | Did not separate | 30 seconds | 1 minute | 30 seconds |

**Table C: Emulsion Observations After Treatment**

| AFTER TREATMENT | | | | |
|---|---|---|---|---|
|  | | | | |
| **Vinegar & Oil** (Control) | **Salt** | **Ground Mustard** | **Honey** | **Paprika** |

## Conclusion:

1. Compare the jars after waiting the 10 minutes to your diagrams in Table C. Describe the changes observed and explain why these changes occurred.

   All the vinegar and oil in the jars began to separate after 10 minutes, however the ground mustard jar did not fully separate (if at all).

2. Compare your initial response to the lab question to the actual results and identify the substance(s) that act as emulsifiers.

   Ground mustard acted the most like an emulsifier. Mustard seeds contain protein, carbohydrate, and oil. When ground, the protein and carbohydrates coat the oil making it hydrophilic and instead of hydrophobic.

3. Compare and contrast the jar labeled *control* to the other four samples.

   The jar labeled control did not create a homogeneous mixture, which was similar to the salt, paprika, and honey jars.

4. Based on your reading, what type of mixture is each sample? (Heterogeneous or Homogenous)

   Vinegar and Oil: Heterogeneous

   Salt: Heterogeneous

   Ground Mustard: Homogeneous

   Honey: Heterogeneous

   Paprika: Heterogeneous

5. Compare and contrast the vinaigrette mixture before and after using the whisk.

   The mixture was layered and separated before using the whisk. After using the whisk, the mixture became homogenous.

6. Describe the appearance of the vinaigrette on the Romaine lettuce.

   The oil and vinegar seemed to fall to the bottom of the plate leaving some on the lettuce and the seasoning stayed on top of the lettuce.

7. Think about the cell membrane and how your observations of water (vinegar) and oil relate to the cell membrane. Why is it important for the cell membrane to be composed of lipids?

   It is important for the cell membrane to be composed of lipids because it acts as a barrier and provides structure for the cell.

# Student Investigations Lab Extension

## MATERIALS

emulsion droplet
1 microscope slide and cover slip
1 microscope
1 dropper
1 small cup of water

## Directions to Use a Microscope

1. Plug the microscope in (if applicable) and turn it on.
2. Adjust the magnification to the lowest power.
3. Make sure the stage is lowered all the way and place the slide on the microscope stage. Slowly raise the stage using the coarse focus knob (large knob) so you can see the object clearly through the ocular lens. Do not let the slide touch the objective lens.
4. Using the fine focus knob (small knob), adjust the focus so the object looks clear.
5. If the object is to dark or too bright, you can adjust the diaphragm until you can see all the details.
6. Once the object is in focus, you may change to higher powers. However, be sure the lens does not hit the slide.

## View Emulsion under Microscope:

1. Obtain a sample emulsion (jar containing identified emulsifier).
2. Make a wet mount slide by placing a drop of water on a clean slide.
3. Place a drop of emulsion on the slide.
4. Observe using the microscope under 4X power and then 10X power.
5. In the box on page 243, draw your observations in high power (10X).

| Fat Emulsion Drawing<br>10x |
| --- |
| |

## Conclusion:

1. Describe your magnified emulsion observations.

# Investigating Your Health:
# Fascinating Fats

**Name:** _____

**Objective:** Investigate fats by comparing the nutrients of a typical fast food meal to a healthier option. Identify and evaluate fats in your diet.

***Saturated fat*** is usually solid at room temperature. It is a type of dietary fat that typically comes from animal sources. Some examples of foods with saturated fat are milk, beef, chicken, butter, and cheese. Your diet should have no more than 30% total fat. But no more than 7% of your total fat amount should be saturated fat. For example, if you need 1,500 calories, only 105 of them should come from saturated fats (e.g. 1 slice of cheddar cheese). Eating a high amount of saturated fat could increase your risk for heart disease.

***Unsaturated fats*** are generally healthier sources of fats. Unsaturated fats are usually liquid at room temperature. There are two types of unsaturated fats: polyunsaturated and monounsaturated. Foods with polyunsaturated fat include soybean oil, corn oil, safflower oil, salmon, herring, trout, walnuts, and sunflower seeds. Some examples of foods with monounsaturated fats are olive oil, canola oil, avocados, peanut butter, and many other nuts and seeds. Replacing saturated fat with unsaturated fat may lower your risk for heart disease.

***Trans fat*** is a man-made type of fat that is formed by adding hydrogen atoms to liquid fats, making solid fats. This process is known as hydrogenation. These fats are usually found in fried foods like French fries, and baked foods like cookies, crackers, margarine, and shortening. Eating trans fat increases your risk for heart disease and stroke, and can increase your likelihood of developing type 2 diabetes. *Trans* fat can be found on the Nutrition Facts label. However, foods can advertise that they have 0g of trans fat if the amount of trans fat is less than 0.5g per serving. It is important to read the ingredients list for the words "partially hydrogenated," indicating the food contains trans fat.

Use the *Try This at Home* recipe to make a healthy dressing to pair with your leafy green vegetables!

# Fast Fats

1. Find and look at the Nutrition Facts for a cheeseburger (about 4 ounces), medium French Fries, and a small soda from your favorite fast food restaurant. Most major fast food restaurants have their nutrition facts listed on their website. If you are unable to find nutrition facts online, use the handout provided by your teacher or access the nutrient database on USDA's website: http://ndb.nal.usda.gov/ndb/foods/search/list. Complete the table below.

**Restaurant Name:** _____

**Sandwich:** Cheeseburger

**Side Item:** Medium French Fries

**Drink:** Small Soda

| | Cheeseburger | French Fries | Soda | Total |
|---|---|---|---|---|
| **Calories** | 300 | 380 | 110 | 790 |
| **Total fat** | 12g | 19g | 0g | 31g |
| **Trans Fat** | 0.5g | 0g | 0g | 0.5g |
| **Saturated Fat** | 6g | 2.5g | 0g | 8.5g |

2. Create a second meal with healthier options from the same fast food restaurant. The meal should include a sandwich, side food item, and a drink. Be sure to list sizes for each item!

**Restaurant Name:** _____

**Sandwich:** Grilled Chicken

**Side Item:** Sliced Apples

**Drink:** Water

| | Sandwich | Side Item | Drink | Total |
|---|---|---|---|---|
| **Calories** | 350 | 15 | 0 | 365 |
| **Total fat** | 9g | 0g | 0g | 9g |
| **Trans Fat** | 0g | 0g | 0g | 0g |
| **Saturated Fat** | 2g | 0g | 0g | 2g |

3. Which meal is the better option? Why?

The grilled chicken sandwich, apples, and water is healthier because it is significantly lower in calories and fat than the cheeseburger, medium French fries, and small soda.

**TEACHER'S NOTE:** When comparing between two meals, students should find the second meal is lower in calories, total fat, trans fat, and saturated fat. For example, if the second meal consisted of a grilled chicken sandwich, sliced apples, and water it would have fewer calories and fat than the meal with cheeseburger, fries, and soda. Make sure students pay special attention to serving sizes. For example, when first glancing at the food labels provided, students may assume the cheeseburger is a healthier option because it is lower in calories. However, the chicken sandwich is a full three ounces larger than the cheeseburger.

4. On the food label below, circle where trans fat is located on the Nutrition Facts label. Then, looking at the ingredients, determine if the food is truly free of trans fat. If it is not, circle the words that indicate it contains trans fat.

**Walnut Maple Pie**

## Nutrition Facts

| | |
|---|---|
| **Serving Size** | 1 slice |
| **Calories** | 320 |
| **Total Fat** | 20g |
| Sat. Fat | 8g |
| *Trans Fat* | 0g |
| **Sodium** | 180mg |
| **Total Carbohydrates** | 32g |
| Dietary Fiber | 1g |
| Sugars | 20g |
| **Protein** | 3g |

| | | | |
|---|---|---|---|
| Vitamin A | 2 % | Vitamin C | 0 % |
| Vitamin E | 0 % | Calcium | 35 % |
| Iron | 4 % | Thiamin | 0 % |
| Niacin | 3 % | Folate | 0 % |
| Vitamin $B_{12}$ | 0 % | Zinc | 0 % |
| Magnesium | 0 % | | |

Ingredients: Evaporated milk, modified corn starch, walnuts, natural and artificial flavor, milk, cream, partially hydrogenated soybean oil, cinnamon, salt, artificial flavor, modified food starch.

# TRY THIS AT HOME:

## Mixed Baby Greens with Mustard Vinaigrette

**Makes 4-6 servings**

### You will need:

**1 tablespoon dry mustard**

**3 tablespoons vinegar**

**Salt and pepper**

**⅓ cup extra-virgin olive oil**

**1 pound mixed baby greens, rinsed and spun dry**

### Prep Time: 10 minutes

### INSTRUCTIONS:

1. Whisk mustard and vinegar in a bowl and lightly season with salt and pepper.

2. Drizzle in the olive oil while whisking.

3. Pour your vinaigrette over the greens.

4. Toss and serve immediately!