Names: _____

*Chem 227/ Dr. Rusay*

### *Protein Chemistry: Amino Acids, Flour, Dough & Elasticity*

**Web Resources:**

> http://www.exploratorium.edu/cooking/bread/glutengood2test.swf
> http://www.exploratorium.edu/cooking/bread/index.html
> http://www.recipesource.com/baked-goods/

**Objectives:**

To relate dough's elasticity to the primary structure of proteins, and apply experimental, material observations on a molecular level.

_____

Read: *"The Chemistry of Cereals" and "Wheat, Flour and the Action of Water"*;

**Procedure:** *Preparing and Comparing Dough*

Your group will be assigned four different flours from the list following **Table 1**. Fill in the Type of each flour for each designation A, B, C, and D.

Slowly add ~30 grams of water to ~80 grams flour (~40% by weight; do not add too much water) for each of the flour type; mix to make a smooth, uniform dough. Roll each dough into a ball. Knead each of them for ~1 minute. Divide each of the doughs into four even amounts taking care to keep track of the identities of each. Take one portion of each dough and compare their relative elasticities by drawing each of them until the dough breaks. Use **Table 1** to compare the flours by recording a 1 for the more elastic of the two, and a zero for the other ( horizontal column + vertical column ). Give each 1/2 for a tie. Total the numbers for each flour and enter the total under "Elasticity" in the second table.

**TABLE 1:**

|   | D | C | B | A |
|---|---|---|---|---|
| **A** |  |  |  |  |
| **B** |  |  |  |  |
| **C** |  |  |  |  |
| **D** |  |  |  |  |

A =

B =

C =

D =

Type: Cake (Ca); All Purpose (AP); Bread (Br); Rye (Ry); Whole Wheat (WW); "Vital Gluten" (VG); Rice (Ri)

Using the remaining portions, take one portion and knead for 3 min., take the second portion, add 1/8 teaspoon of salt and knead for ~1 minute. To the third portion add 1/4 teaspoon of lemon juice and knead for ~1 minute, compare their relative elasticities of each to their elasticitiy before addition and record your observations as: (+) elasticity increases; or (0) remains the same; or (–) elasticity decreases. Provide the results of both Tables to Dr. R. on the separate form which was provided.

*TABLE 2:*

| Type of Flour | Elasticity | Observations (Kneading) | Observations (Salt) | Observations (Lemon Juice) |
|---|---|---|---|---|
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

1. Glutenin and gliadin have very few charged amino acids. Therefore, flours are not very soluble in water. However, about 40% of the amino acid residues in the proteins are glutamine. *a)* Draw a structure for glutamine. *b)* Draw a second structure, which results from two glutamine molecules combining, where the α-carbon's amine reacts with the carboxylic acid of the other glutamine molecule to form an amide. *c)* Using chemical principles, briefly explain why the glutamine distribution in the proteins relates to the intermolecular interaction between flour and water to form dough.

| | |
|---|---|
| *a)* | *b)* |
| *c)* | |

2. *a)* List the flours in increasing order of gluten content based on your ranking of dough elasticity. *b)* Briefly describe the theoretical chemical/molecular basis which can explain the observed effects of lemon juice and salt on the elasticity of dough.

*a)* _____ < _____ < _____ < _____

*b)*

3. What general pattern in the side chain substituent, R'-, is observed in *(a)* Highly Hydrophilic amino acids and *(b)* Hydrophobic amino acids? Briefly explain how this affects the amino acid's affinity for water.

*a)*

*b)*

4. What does kneading do to the quality of dough? Can too much kneading affect the quality of the dough? Briefly explain your answers and reasoning.

5. Which level(s) of protein structure are significant in explaining the general eleasticity of dough? *Circle all that apply. 1º, 2º, 3º, 4º*   Briefly explain the reason(s) for your choice(s).