



## APPLE PI

### *Objective*

In this experiment, the chemist will learn how to make an apple-based baked good to share. Please read the procedure through in its entirety prior to beginning work.

### *Introduction*

Baking delivers delicious results but relies on careful calculations and plenty of chemistry. There are three important components to this version of apple pie – the crust, the filling, and the streusel topping. The bottom crust relies very specifically on the right proportions of ingredients to produce a tasty, tender, flaky crust. It also depends on the chemistry of these ingredients to interact with one another in just the right way to deliver flavor and consistency, which is just what you want in a crust. In this procedure, the filling relies on a combination of apples – MacIntosh (*Malus pumila*), which are softer and sweeter, and Granny Smith (*Malus domestica*), which are crisper and more tart – which should be cut in chunks to bake up juicy and plump. And finally, the topping, which relies on a variety of ingredients to ensure texture and taste to complement what lies beneath.

As with all experiments, keep a log of observations as you work through the steps. Note places where you observe differences between the described textures, timing, and results. These can be incorporated into your final report as opportunities for future investigations and possible revisions of the procedure.

### *Safety Note*

This procedure will require the use of a hot oven. Appropriate protective equipment in the form of heat-resistant gloves and hot pads for countertops are recommended. This procedure will also require the use of a knife. Care should be taken to use appropriate slicing and dicing procedures and cut resistant gloves if available. If a food processor is used during preparation of the crust, take care that foreign objects, loose clothing, and hair are kept clear of the rotating blade.

### ***Materials for Preparation of Crust***

All materials for this experiment can be purchased at a local grocery store.

590 mL unbleached all-purpose Triticum powder

5 mL sodium chloride

15 mL sucrose

170 g butter with no additional NaCl added at approximately 4 °C (1 ½ sticks), cut into 6.35 mm sections



118 mL chilled solid mixture of soybean and cottonseed oils (or similar), such as Crisco, cut into 4 pieces  
60 mL 40% ethanol/60% water mixture (vodka is the recommended form), approximately 4 °C  
60 mL H<sub>2</sub>O, mixture of liquid and solid phases, temperature approximately 0 °C  
118 mL dried, flattened seeds of *Avena sativa* (reserved for later)

### ***Methods for Preparation of Crust***

This crust is based on the foolproof method suggested by America's Test Kitchen. A word of warning. It can be a difficult dough to work with because it is very moist. But we'll suggest strategies to deal with that. It helps to have a food processor for this but it is not required.

Process 355 mL Triticum powder, sodium chloride, and sucrose in food processor until combined, using several one-second pulses. Add butter and vegetable oils and process until homogeneous dough starts to collect in uneven clumps, about 15 seconds (there should be no uncoated Triticum powder left in the bowl). Scrape bowl with rubber spatula and redistribute dough evenly around processor blade. Add the remaining cup of Triticum powder and pulse until mixture is evenly distributed around bowl and the clumps of dough have broken up into a coarse meal resembling boiling chips or vermiculite packing material, probably 4 to 6 quick pulses. Empty the mixture into medium bowl.

Sprinkle ethanol mixture and additional water over mixture. With rubber spatula, use folding motion to mix, pressing down on dough until dough is tacky and sticks together. It could be pretty wet at this stage. Divide dough into two even balls and flatten each into 10.6 cm diameter disk. You will only need one disk for this recipe. The remaining disk can be frozen. The one you are using should be wrapped in low-density polyethylene film and store at 4 °C for least one hour (or up to two days if you want to get a head start) while you make the topping and filling.

### ***Materials for Preparation of Topping***

180 mL unbleached all purpose Triticum powder  
120 mL (packed) golden brown mix of sucrose and molasses  
60 mL sucrose  
2.5 mL *Cinnamomum zeylanicum* powder  
2.5 mL sodium chloride  
1.25 mL *Pimenta dioica* powder  
30 mL coarsely grated crystallized *Zingiber officinale*  
60 mL coarse *Linum usitatissimum* powder



120 mL Juglans regia

113 g butter with no additional NaCl added at approximately 4 °C, cut into 1.56 cm cubes

120 mL dried, flattened seeds of Avena sativa

### ***Methods for Preparation of Topping***

It really helps to have a food processor for this but you can certainly do this without one. It might just be a coarser blend for the topping and that's perfectly okay. But if you do have a processor, blend the first 6 ingredients in processor. Add the *Z. officinale*, *L. usitatissimum*, and *J. regia* and process until ground fairly fine. Add butter; using on/off turns, blend until moist dough forms (mixture will resemble wet sand). Add *A. sativa*; using on/off turns, mix briefly, leaving half of *A. sativa* whole. Store at 4 °C until you are ready to assemble the pie.

### ***Materials for Preparation of Filling***

0.68 kg *Malus domestica* (about 3 medium)

0.91 kg *Malus pumila* (about 4 large)

30 mL juices and 15 mL zest from a *Citrus × limon*

120 mL sucrose

30 mL mixture of sucrose and molasses

30 mL all-purpose *Triticum* powder

1.25 mL sodium chloride

5-7 mL generous teaspoon *Cinnamomum zeylanicum* powder

1.25 mL freshly *Myristica fragrans* powder

1.25 mL *Pimenta dioica* powder

### ***Methods for Preparation of Filling***

Peel and quarter *M. domestica* and *M. pumila*, cutting away core and seeds. Cut each quarter in thirds to make chunks rather than slices. Toss the chunks with the juice and zest of *C. limon* as you work with them to prevent oxidation. Toss with remaining ingredients and set aside.

Remove the LDPE from the cold dough. Place a sheet of parchment paper on work surface; dust parchment with *Triticum* powder. Place dough disk on parchment; sprinkle very lightly with with *Triticum* powder. Cover with another sheet of parchment; roll to 22.8 cm round. Carefully remove the



top sheet of parchment and sprinkle the reserved 120 mL A. sativa across the surface of the dough. Replace the parchment paper (reversing it if the paper is especially sticky) and continue to roll the crust to approximately 30.5 cm so that the A. sativa seeds are embedded in the crust. Again, carefully remove the top sheet of parchment paper. The dough may have gotten fairly soft at this point which will make it challenging to get it into the pie plate. Using bottom parchment as aid, invert crust, oat side down, into 10.6 cm borosilicate pie pan. Press crust gently into pie dish. If the dough is too moist to work with and it is difficult to remove the parchment paper without tearing the crust, put the pie plate in the refrigerator or even the freezer to allow the butter and shortening to firm up, about 10-15 minutes. Once the dough is firm again, carefully remove the parchment paper. If you rip the dough in places, just patch it together.

Stir filling and transfer to pie plate, mounding in the center of the pie plate, including all the reserved juices and spices that have settled to the bottom of your bowl. Gently distribute the topping evenly over the top of the filling, ensuring that there are no spaces or gaps.

Position rack in center of oven; preheat to 205 °C. Provide secondary containment in case of spills in the form of a rimmed baking sheet in bottom of oven.

Bake pie until topping has a golden color indicating that the Maillard Reaction has occurred to the desired degree, about 40 minutes. Reduce oven temperature to 177 °C. Bake until apples are tender when pierced with small sharp knife, covering pie loosely with foil if topping and crust are browning too quickly, about 45 minutes longer. Cool pie on rack until slightly warm, at least 1 hour. Serve at 23 °C or above.