Chicken Fajitas: The Chemistry Behind a Tasty Dish

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Introduction

My group decided to make chicken fajitas because I wanted to try something new in the kitchen and explore the chemistry behind a dish I already enjoy. I cook from time to time, but I have never really understood the chemistry involved. I was excited to see how the different ideas we learned in the lecture and the skills in the lab would affect the dish. This project gave me a chance to practice cooking more intentionally while learning what happens at the molecular level.

We chose chicken fajitas for our dish because they are versatile and flavorful, allowing us to explore both the culinary science of cooking meat and vegetables and the rich cultural history of Tex-Mex cuisine. All three members of our group are from the East Coast, and we have minimal knowledge, consequently, of Tex-Mex cuisine. While we prepared this dish, we were excited to see the chemical reactions happen in real time.

While I was planning the project, I felt both curious and motivated. I wanted to see if understanding the science would actually make me a better cook. I

approached every step with attention, from mixing the marinade to watching the chicken change color on the grill. By the time we finished plating the fajitas, I was proud not just of how they tasted, but of how much I had learned about the chemistry behind them. I will hopefully continue trying out new dishes in a mix of new methods due to the knowledge learned in this class.

Recipe

For the fajitas:

- 1 1/4 to 1 1/2 pounds skinless, boneless chicken breasts
- Salt, to taste
- 2 tablespoons canola or extra virgin olive oil
- 1 large onion, sliced lengthwise (root to tip) into 1/4-inch strips
- 3 pepper bell peppers (various colors), sliced into 1/4-inch strips (*removed from our making of the dish due to allergy)

For the marinade:

- 1/4 cup chopped fresh cilantro
- 1/2 jalapeño pepper, seeded and minced
- 1 clove garlic, minced
- 3 tablespoons extra virgin olive oil
- 2 tablespoons lime juice
- 1/2 teaspoon salt
- 1/2 teaspoon ground cumin
- 1/2 teaspoon chili powder

For serving

- 8 to 12 flour tortillas
- Homemade or store-bought salsa
- Sliced avocado or guacamole
- Sour cream
- Thinly sliced iceberg lettuce dressed lightly with salt and cider vinegar

Cooking Instructions:

1. Cut thick chicken breasts in half horizontally: If you have chicken breasts that are around a half pound each or more, you will want to slice them in half horizontally, so that the center thickness is around 1/2-inch to 3/4-inch thick.
2. Marinate the chicken: Mix all the marinade ingredients in a glass or plastic container. Add the chicken, mix well, cover, and let marinate at room temperature for 30 minutes or refrigerate for up to 8 hours.
3. Remove the chicken from the marinade: Wipe off most of the marinade and sprinkle the chicken pieces with salt.
4. Sear the chicken on high heat: Heat a tablespoon of oil in a large cast iron frying pan on high heat for a minute or so. As soon as the oil begins to smoke, lay the chicken breast pieces in the pan. Depending on the size of the pan and if you have had to cut the chicken breasts, you may have to work in batches. Let the chicken cook undisturbed for 2 to 3 minutes until it has a

good sear. Once seared well on one side, turn the pieces over and cook for another 2 to 3 minutes until well seared on the second side.

5. Stack the seared breasts, cover with foil, and let rest: Once seared on the second side, remove to a cutting board and cover with aluminum foil to rest for 5 minutes. If you want to test for doneness, cut into one piece with the tip of a sharp knife. It should be just done; if not, you can put it back in the hot pan for a minute or two. A tip we used was: Stack the seared chicken breasts, then cover them with foil. Together, they will retain heat better as you cook the peppers and onions.
6. Sauté the peppers and onions: While the chicken rests, cook the peppers and onions. Add another tablespoon of oil to the frying pan. Heat on high. As soon as the oil is hot, add the onions and peppers to the pan. Use a metal spatula to scrape some of the browned bits from the chicken and stir to coat the onions and peppers with the oil and brown bits. Spread the onions and peppers in an even layer in the pan. Let them cook undisturbed for 2 minutes. You want them to be seared and blackened. Stir the vegetables, then continue cooking for another 2 minutes.
1. Slice the chicken and serve: Slice the chicken across the grain into strips. Serve at once with the peppers and onions, some warm tortillas, and sides of shredded cheese, salsa, guacamole, and/or thinly sliced iceberg lettuce dressed with vinegar and salt.

Science Behind the Dish

1. Marination

The lime juice in the marinade contains citric acid, a weak organic acid that begins to break hydrogen bonds and disrupt protein structure on the chicken's surface. This process, partial protein denaturation, loosens the protein network, allowing flavors to penetrate slightly below the surface. Salt further enhances this effect: when NaCl dissolves, Na^+ and Cl^- ions diffuse into muscle fibers, increasing water retention through osmotic interactions. Olive oil plays a different role; because it is hydrophobic, it carries fat-soluble flavor compounds from spices and helps them adhere to the chicken.

2. The Maillard Reaction

When I placed the marinated chicken on the hot grill, the first noticeable change was the smell – an aroma signaling the Maillard reaction. This reaction occurs when amino acids and reducing sugars combine at high heat, producing hundreds of new flavor molecules. It is responsible for the browning on the chicken's surface and the savory, roasted flavor typical of fajitas. Because the grill reaches temperatures well above 300°F, the reaction proceeds quickly, forming a browned crust while keeping the interior moist.

3. Caramelization of Vegetables

The onions undergo caramelization, a distinct but related reaction that involves the breakdown of natural sugars. As sucrose and other sugars decompose, they form new aromatic compounds and brown pigments, giving the vegetables sweetness and color. Allowing them to sit steadily in the pan increases this browning because the surface temperature remains high.

4. Post-sear Rest

The last scientific component of this dish is the resting and moisture retention. After the chicken sears, it needs to rest. This resting time allows the juices inside the chicken to redistribute, as denatured proteins relax and reabsorb water molecules (Pang, 2021). This process keeps the meat juicy and delicious when it is time to serve. This last step is of utmost importance, as if it does not have time to rest, the marination and Maillard reaction will not be as effective as they can be during the cooking process.

Nutrition Facts - 1 serving (Bauer n.d.)

- Calories: 355
- Total Fat: 21 g
    - Saturated Fat: 3g
- Cholesterol: 103 mg
- Sodium: 607 mg
- Total Carbohydrates: 8g
    - Dietary Fiber: 2g
    - Total Sugars: 3g
- Protein: 33g
- Vitamin C: 49 mg
- Calcium: 37 mg
- Iron: 1 mg
- Potassium 647 mg

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