An Impossible Burger for an Impossible Problem

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Eating meat, in its current state, is unsustainable. Not only will meat production not be able to keep up with the global population, but the modern meat industry is a leading factor in climate change. Meat consumption is highly correlated with economic development and, combining that with our population growth, experts project a 75-80% increase in meat consumption by 2050 (Ritchie, Reay, & Higgins, 2018). Additionally, livestock uses up more land than it is worth. Of all the land used for agriculture in the world, 77% is used for livestock despite global caloric consumption from animals only being 17% of our diets (Dent, 2020). When it comes to emissions, livestock farming also generates more greenhouse gases than all the worlds' cars, trains, planes, and boats by nearly 50% (Walsh, 2008). Unless the demand for meat changes drastically in the future (unlikely), lab-grown meat alternatives are going to be essential to satisfy those who can't go without. Leading the meat alternative charge is the Impossible Burger, manufactured by Impossible Foods and invented by its founder and American scientist, Patrick O. Brown.

Founder of Impossible Foods, Pat Brown / Credit: Vulcan Post

Impossible Foods' company overview page on their website explains how Pat Brown came to create the first Impossible Burger. In 2009, he changed careers from a Professor of Biochemistry at Stanford University to attempt to address the problem of climate change. His target: the global food system. Brown was well aware of the unsustainability of its current state and the potential for world-altering problems should it continue down its projected path. So, he set out to make meat, fish, and dairy products out of plants- with far smaller carbon footprints. After an 18-month sabbatical from Stanford University and noticing both the need from the climate and the desire by consumers for a *good* plant-based burger alternative, he created Impossible Foods on July 16th, 2011. Brown recruited fellow scientists to analyze the smells, tastes, textures, and cookability of meat to determine why meat is what it is, and how we could possibly replicate it using plants. After years of research and the development of proprietary technology to recreate the sensations of eating real meat with an entirely plant-based substitute, in 2016 Impossible Foods debuted the Impossible Burger.

An Impossible Burger cut in two. / Credit: cnet

The Impossible Burger's claim to fame is thanks to an ingredient called heme. Heme, or soy leghemoglobin, is a protein found in every living being, both animals and plants, and arguably essential for life on earth. The heme in our blood is responsible for grabbing the oxygen from our lungs and carrying it all around our bodies. It also happens to be what makes the Impossible Burger "bleed" and taste like a real beef burger. The scientists at Impossible Foods were the first to discover that heme was the ingredient in meat that made it something we, as humans, crave. It is highly abundant in animal muscle tissue and mostly responsible for the smell, texture, and taste of meat when you cook and eat it (Heme - The Magic Ingredient in the Impossible™ Burger, 2017). After discovering heme's importance in real meat, they began work creating a process to make their own heme to infuse plant-based burgers with. Pat and his fellow biochemists came up with the process of taking the DNA out of the roots of soy plants, adding it to a particular yeast, fermenting it, and then adding it to the other plant-based burger ingredients (Reiley, 2019).

Uprooted soy plant and bowl of heme. / Credit: ImpossibleFoods.com

While heme is the prime contributor of the flavor for the Impossible Burger, there are several other important ingredients that make the burger flavorful, textured, and nutritious. For protein, Impossible Foods decided on using both potato and soy proteins for texture and nutritious value. Soy is known as a very high-quality protein, one of very few that contain proteins similar in digestibility to actual animal protein. It is also high in fiber, iron (important as a meat substitute), potassium, phosphorus, and magnesium. However, with any protein substitute, there have been (unfounded) concerns from the public about its healthiness that have sprouted into three major myths. First myth: eating soy can cause breast cancer in women. This has been disproven and, actually, studies have shown soy to potentially reduce the risk of breast cancer. Second myth: soy can change men's hormones and cause infertility. Again, multiple controlled studies have shown no consistent link between consuming soy and male infertility or hormone imbalance. Third myth: soy can affect a person's thyroid hormones. Studies have shown that there are no effects, or statistically insignificant effects, to thyroid hormones due to soy consumption (Klapholz). With soy myths disproven, there's really no reason not to enjoy soy-based burger substitutes- especially if they happen to taste remarkably like the real thing.

Soy/potato protein with heme (red) being mixed in. / Credit: Quartz

Coconut and sunflower oil. / Credit: Impossible Foods

In addition to protein, there are fat substitutes in the Impossible Burger that are used for taste, satiation, and that "juicy sizzle" while cooking. Impossible Foods use coconut and sunflower oils as their fat substitute. In their Impossible Burger 1.0 version, they clocked in at 14 grams of fat, 8 grams being saturated fat (the bad kind) from the coconut oil which was the primary fat responsible for that "sizzle" while cooking. In the Impossible Burger 2.0, however, they have replaced a portion of the coconut oil with sunflower oil which is unsaturated fat to make the burger healthier without sacrificing the overall eating experience (Reiley, 2019).

Finally, as with all modern substitute meat burgers, there needs to be something in the recipe that holds everything together well enough to allow the meat to cook on a grill without falling apart. These are called *binders* and are mixed in with all of the protein, heme, and fat. Impossible Foods decided to use methylcellulose, which is a binder used for jam, sauces, and ice cream, as well as food starch, which is a carbohydrate that is in a lot of food such as canned soup (ImpossibleFoods.com). These work with the protein, fat, and heme to hold everything together and ensure the meat doesn't crumble (a very common flaw in plant-based burger substitutes).

How does the Impossible Burger compare nutritionally to a regular burger? As it turns out, they're extremely similar, if not slightly healthier. A four-ounce serving of the Impossible Burger clocks in at 240 calories, 19 grams of protein, 14 grams of fat, 370 mg of sodium, and no cholesterol. Comparatively, a single beef patty has 287 calories, 19 grams of protein, 23 grams of fat (9 of which are saturated), 75mg of sodium, and 80 mg of cholesterol. At face value, we can see that beef has more calories, more fat, and more cholesterol. However, it also has almost one-sixth of the sodium. This is where consumers have to make the decision about what fits into their specific current diet based on those numbers. Someone with hypertension might avoid eating an Impossible Burger due to the sodium. However, someone with high cholesterol might choose the Impossible Burger over a real beef patty due to the lack of any cholesterol. Outside of the basic macronutrients, however, is where the Impossible Burger really shines. They have 4 times the calcium, 2.5 times the iron, and more than double the potassium of a regular beef burger (Davis, 2020). Not to mention all of the fiber and magnesium from the soy protein. Let's be honest, when you eat a burger, you aren't typically looking for something healthy, you're looking for the taste and experience of eating

	BEEF (80/20)		IMPOSSIBLE BURGER	
Calories	287		240	
Protein	19 g		19 g	
Total Fat	23g		14 g	
Sat Fat	9 g		8 g	
Trans Fat	1.3 g		0 g	
Cholesterol	80 mg		0 mg	
Total Carbs	0 g		9 g	
Dietary Fiber	0 g		3 g	
Sugars	0 g		1g	
Sodium	75 mg	(3%)	370 mg	(16%)
Calcium	20 mg	(2%)	100 mg	(8%)
Iron	2 mg	(10%)	5 mg	(25%)
Potassium	305 mg	(7%)	610 mg	(15%)

Nutrition for beef vs. impossible burger / Credit: Medium.com

a burger. So, while the Impossible Burger doesn't blow regular burgers out of the water health-wise, they taste just about as similar as possible with the cherry on top that there's a real case for their nutritional value when compared to a beef burger.

Half of an Impossible Burger / Credit: cnet

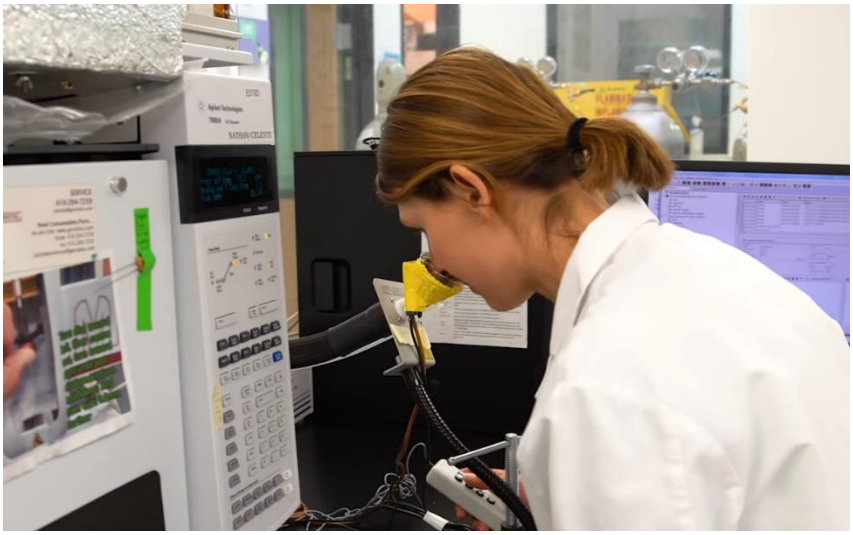
Pat Brown set out to solve the complex problem of an unsustainable food system and decided on taking on the meat industry, specifically. This was no small task. The global meat industry is worth over two trillion dollars and growing. In the US alone, it produced over 100 billion pounds of meat, a figure that is growing by 2-3% a year, and accounts for over 5% of the US GDP. It employs over 5.4 million people, earning over 257 billion dollars in wages, allowing for meat to be extremely cheap for Americans today (Dent, 2020) compared to the Impossible Burger's higher price tag (something Impossible Foods is working to lower through scaling). Despite a slow trend away from meat consumption, general attitudes about meat are still very favorable. A study called *Consumer preferences for farm-raised meat, lab-grown meat, and plant-based meat alternatives: Does information or brand matter?* by Loo, Caputo, and Lusk found that,

of 1800 US consumers who were surveyed, 72% chose farm-raised beef while only 7% chose animal-like alternatives such as the Impossible Burger (Loo, Caputo, & Lusk, 2020). Changing the minds of consumers with well-established attitudes about a cheap American staple food item is a hard battle to fight. This is why Brown placed so much emphasis on cultivating an experience as similar as possible to burgers, with the goal of it becoming completely indistinguishable from the real thing.

This brings us back full circle. In an article called *The Biography of a Plant-Based* Burger by Rowan Jacobsen, Pat Brown was interviewed about how Impossible Foods started. After his 18-month sabbatical focusing on the problem of the unsustainable food system, and a fruitless National Research Council workshop called "The Role of Animal Agriculture in a Sustainable 21st Century Global Food System," Brown realized that consumers will never be persuaded to ditch real meat unless an equal or better option becomes available to them. "All you have to do is make a product that the current consumers of meat and dairy prefer to what they're getting now," he said. "It's easier to change people's behavior than to change their minds." This is where conducting research on the overall user experience of eating a burger becomes paramount, which is exactly what Pat Brown and his team of neuroscientists did. This was done using a variety of equipment Pat states has been

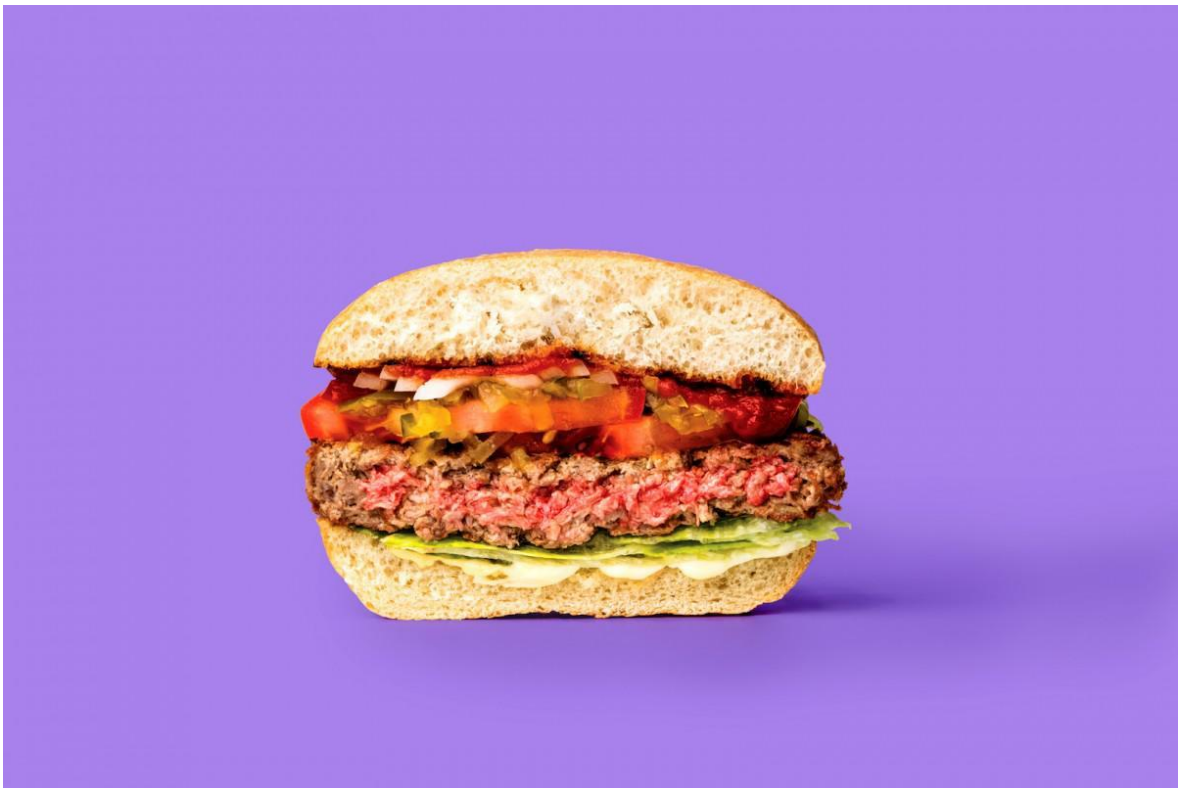
The Impossible Burger / Credit:healthyish

around for over 40 years in the biotech world but is somehow brand new to the "behind the times" food industry. One machine, in particular, separates aroma molecules which identifies the molecules and sends them through a tube where a scientist can personally smell and document what aroma they sense from it. The smell of a single burger itself can be built on over 150 unique aromas that, when combined, smell like a burger to our nose and brains. They can be the smells of "butter, caramel, dust, garbage, a struck match, lilacs, but not meat. But they become meat [taps head] up here" Brown explained (Jacobsen, 2016).



Scientist smelling isolated aroma molecules / Credit: Quartz

Impossible Foods also sampled a large number of different beefs to find the burger flavor they wanted for their Impossible Burger. Intending on creating an experience as close to a classic burger as they could, they conducted taste tests to find the beef that tasted most representative of just that. They sampled some of the best award-winning beef such as the highly sought-after Kobe beef but found that it did not significantly outperform mid-range beef such as Safeway 80/20, which they eventually decided on. They found that it was the most standard beef in most people's experience and was a very good reference point to base their taste, smell, and texture profiles on (Jacobsen, 2016).



An Impossible Burger Cross-Section / Credit: Forbes

In conclusion, the aroma and taste user research, combined with the development of proprietary technology in the form of “heme”, creates a burger-eating experience described as “bloody and red, and it cooks and tastes like an actual beef patty” as mentioned in the video *The science behind the Impossible Burger* on YouTube by Quartz, a digital news outlet. Using neuroscience, Impossible Foods catered the entire experience to our senses engaging our hearing, smelling, seeing, and tasting while eating an Impossible Burger with the intention of making the mind believe it is a real burger. The coconut and sunflower seed fats sizzle and pop like a real beef patty would on the grill. Through aroma research, they were able to replicate the smell a burger gives off before and after it is cooked. The heme creates the illusion of bleeding as a real burger would and mimics the taste of real animal muscle tissue. Altogether, it tricks the mind into believing one is eating an actual burger, satisfying both the diner and the conundrum of an unsustainable meat industry.

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