

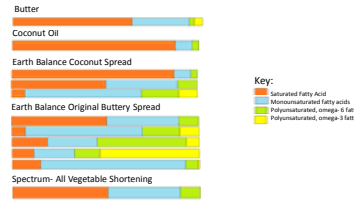
Introduction

The proportion of Americans following a vegan diet has increased substantially in the past 15 years from approximately 300,000 to 500,000 people in 1997 to between 2.5 and 6 million in 2012 (1–2% of the U.S. population) (Radnitz, Beezhold & DiMatteo, 2015). The reasons for choosing a vegan lifestyle include health, animal rights (ethics), environmental concerns, influence of others, and sensory disgust, with health and ethical considerations emerging as the most often cited reasons. Foods consumed on a vegan diet are diverse and can include fruits, vegetables, legumes, nuts, seeds, healthy fats, and whole grains. However, as the number of vegan consumers has risen, there has been a corresponding rise in vegan food product replacements (Radnitz, Beezhold & DiMatteo, 2015). One such area is the replacement of animal fats by vegan fat substitutes. Using butter as the control, this project tests the acceptability of four vegan fat replacements in the making of pie crust.

Butter which consists of butter fat, milk proteins and water is used in the standard pie crust recipe. In addition to the concerns of the vegan population, butter contains high levels of saturated fats and cholesterol. Two of the replacement vegan fats are single ingredient, shelf stable products. The first is **Spectrum- All Vegetable Shortening** which contains mechanically pressed organic palm oil. The second single ingredient product is **Spectrum Coconut Oil**. While both these products contain saturated fat along with mono and poly unsaturated fatty acids, they are the lesser processed replacements used. Additionally, in the case of the coconut oil which contains medium chain fatty acids, new research may support the health benefits of this product (Radnitz, Beezhold & DiMatteo, 2015).

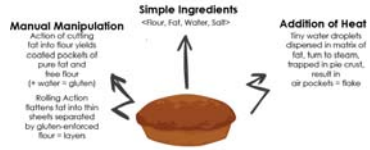
The second replacement products require refrigeration and contain a mix of organic and other additives. **Earth Balance Original Buttery Spread** contains a proprietary blend of tropical oils which include palm, canola, soy bean, flax and olive oils. Additives to the spread include less than 2% pure salt, natural flavor, sunflower lecithin and non-dairy lactic acid. **Earth Balance Coconut Spread** is also a proprietary blend of coconut and palm oils, filtered water and includes less than 2% pure salt, natural flavor, sunflower lecithin and non-dairy lactic acid. These spreads, with the added salt, have more sodium than the other fats at 100 mg and 70 mg, respectively. These product contains saturated, mono and poly unsaturated fatty acids.

Fat Differences:



Key:
Saturated Fatty Acid
Monounsaturated Fatty Acid
Polysaturated, omega-3 Fatty Acid
Polysaturated, omega-6 Fatty Acid

Science Builds a Better Pie Crust



Materials and Methods

Methods

1. Preheat oven to 425° F (220° C).
2. In a large bowl, combine 1 cup flour, ¼ tsp salt, and cut in 5 tbs of fat substitute.
3. Blend with a pastry blender until mixture resembles coarse crumbs.
4. Sprinkle with 2 tbs of water.
5. Toss mixture with a fork until it begins to form a ball.
6. Shape a ball with your hands. Do NOT knead. Work quickly so the heat from hands does not begin to melt the solid fat.
7. Place dough ball on wax paper. Flatten with hands.
8. Place another sheet of wax paper on top of the dough and roll with the rolling pin until 1/8 inch thick.
9. Peel off the upper wax paper.
10. Pick up the dough with the sheet of wax paper, turn it upside down and place dough on parchment paper on cookie sheet.
11. Peel off wax paper.
12. With the pizza cutter, score into 2 inch squares. Do not separate the pastry as you cut.
13. Prick each wafer three to four times with a fork.
14. Bake for 8-10 minutes or until edges are light brown.
15. Repeat steps 1-14 for all versions.

Supplies

- 5 cups all purpose flour
- Vegan Fat Substitutes
 - 5 tbsp. Coconut Oil
 - 5 tbsp. Spectrum- All Vegetable Shortening
 - 5 tbsp. Earth Balance Original Buttery Spread
 - 5 tbsp. Earth Balance Coconut Spread
- 5 tbsp. Butter
- 1 ½ tps. Salt
- Water

Equipment

- Cookie Sheets
- Mixing bowls
- Pastry Blenders
- Dry Measuring cups
- Measuring Spoons
- Spatula
- Fork
- Pizza Cutter
- Cooling Rack
- Parchment Paper
- Wax Paper

Acceptability of Vegan Fat Substitutes in Pie Crust

By MJ Brown and Christine Leonard



Four vegan fat substitutes were tested with butter as the control to determine which products would be acceptable substitutes. They were tested using objective measurements for the liking of the flakiness, mouthfeel, aftertaste and overall flavor as well as the intensity of the buttery and salty flavor. The subjective measurements included height, water activity, and moisture content.

Table 1: Height of 4 wafers of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

| Sample | Height (cm) |
|---------------------------------------|-------------|
| Spectrum- All Vegetable Shortening | 2.5 |
| Earth Balance Original Buttery Spread | 2.5 |
| Coconut Oil | 2.9 |
| Butter | 2.5 |
| Earth Balance Coconut Spread | 2 |

Table 2: Water Activity of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

| Sample | Water Activity |
|---------------------------------------|----------------|
| Spectrum- All Vegetable Shortening | .1171 |
| Earth Balance Original Buttery Spread | .0842 |
| Coconut Oil | .0318 |
| Butter | .0078 |
| Earth Balance Coconut Spread | .1569 |

Table 3: Moisture Content of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

| Sample | Moisture Content |
|---------------------------------------|------------------|
| Spectrum- All Vegetable Shortening | 2% |
| Earth Balance Original Buttery Spread | 4% |
| Coconut Oil | 5.9% |
| Butter | 9% |
| Earth Balance Coconut Spread | 2% |

Figure 1: Average liking of the flakiness of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

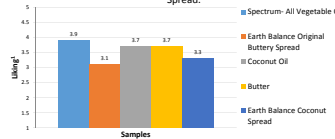


Figure 2: Average liking of the mouthfeel of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

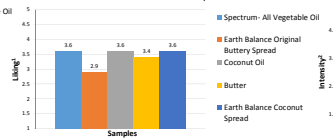


Figure 3: Average intensity of the buttery flavor of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

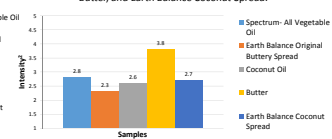


Figure 4: Average intensity of the salty flavor of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

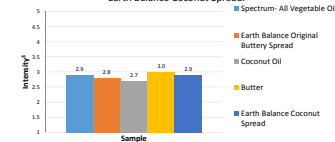


Figure 5: Average liking of the flavor of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

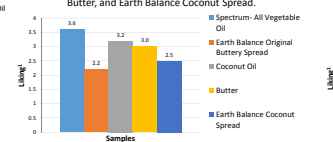


Figure 6: Average liking of the aftertaste flavor of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

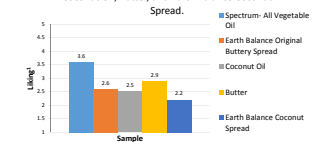


Figure 7: Average liking of the overall flavor of pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.

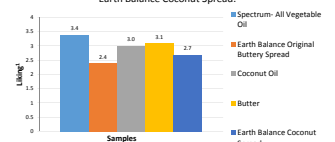
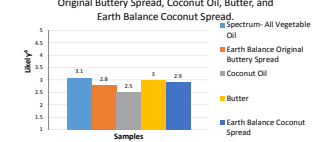
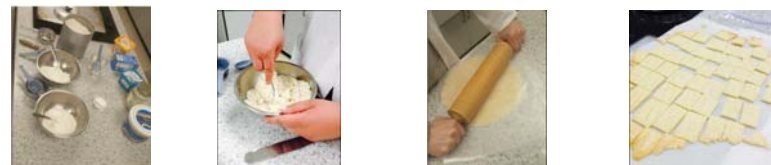


Figure 8: Average likelihood to substitute a vegan fat for animal fat after tasting pie crusts made with Spectrum- All Vegetable Shortening, Earth Balance Original Buttery Spread, Coconut Oil, Butter, and Earth Balance Coconut Spread.



Below are a few snapshots of the processes used in the making of the pie crust:



Results

In determining flakiness (as seen in **Figure 1**), Spectrum- All Vegetable Shortening was found to be the most liked. However, the overall average of liking for flakiness was 3.5 (which reflects a difference of only 0.8 between the highest ranked, Spectrum- All Vegetable Shortening, at 3.9 and the lowest, Earth Balance Original Buttery Spread, at 3.1). Three samples tied for liking of mouthfeel at 3.6 (Spectrum- All Vegetable Shortening, Coconut Oil and Earth Balance Coconut Spread); Earth Balance Original Buttery Spread had the lowest liking rank at 2.9 (**Figure 2**). It was no surprise that the Butter sample was selected as tops for butter flavor at 3.8 (**Figure 3**). The sample scored second in intensity for butter flavor was a full point behind at 2.8 for Spectrum- All Vegetable Shortening. There was a tight consensus on the intensity of saltiness in the samples with a range of less than 0.2 with the Butter sample ranked as ideal saltiness (3.0, **Figure 4**). All other samples were clustered between 2.7 and 2.9. Spectrum- All Vegetable Shortening again took top honors at 3.6 in terms of liking of flavor with Coconut Oil ranked second at 3.2 and Earth Balance Original Buttery Spread again the laggard at 2.2 (**Figure 5**). For aftertaste, only the Spectrum- All Vegetable Shortening scored beyond the midpoint for liking at 3.6; all other samples were in the "somewhat dislike" range (**Figure 6**). Earth Balance Coconut Spread scored its lowest ranking in this category with a 2.2 "somewhat dislike" result. When tasters were asked to consider all aspects of the sample (flakiness, flavor, mouthfeel and aftertaste), it was not surprising to find Spectrum- All Vegetable Shortening on top at 3.4 or Earth Balance Original Buttery Spread as the least liked at 2.4 (**Figure 7**). Lastly, when asked if they would consider substituting vegan fat for animal fat in pie crust, no tasters considered that scenario to be either somewhat or extremely likely. Overall score for the category was 2.8, a ranking between unlikely and no opinion (**Figure 8**).

Discussion and Conclusion

Water activity measures were lowest in coconut oil, butter and Spectrum- All Vegetable Shortening which are all single fat products. The higher processed products with multiple ingredients, Earth Balance Buttery Spread, and Earth Balance Coconut Spread, had higher water activity levels. However, data show butter failed to capture a single top spot in any of the five liking tests. In terms of intensity of butter flavor and saltiness, butter did capture the top spot for butter flavor with a 3.8 ranking and ideal saltiness with a 3.0 ranking.

Mouthfeel characteristics of food generally refer to the perception of moisture or fat (e.g., wet, oily, greasy) as found by Shrager, Lipsky, Stellar & Greenwood (1998). Interestingly, data in **Table 3** show that the sample prepared with Coconut Oil had the highest moisture content levels with Spectrum- All Vegetable Shortening and Earth Balance Coconut Spread tied at third; these three products were in a three way tie for highest liking ranking for mouthfeel (**Figure 2**). This combination of moisture and fat support the previous findings. None of the replacement fats contained any flavorings to impart a butter taste and other than Earth Balance Original Buttery Spread, none of the fats used the term butter flavor. It is very interesting that the tasters ranked all samples as having some measure of butter flavor with an overall average of 2.8 (ideal butter flavor was ranked at 3.0). This butter flavor ranking may be due to the expectation that the pie crust will have a butter flavor more than an actual flavor.

Water activity measures lowest coconut oil, butter and spectrum all vegetable shortening single fat least processed products whereas the higher processed products with multiple ingredients, Earth Balance Buttery Spread and Earth Balance Coconut Spread has higher water activity levels. Whether or not these rates of water activity would correspond to oxidation rates were not determined during the process (**Table 2**).

Many factors could have influenced the resulting height of the wafers including temperature of the fat, rolling pressure and how quickly the water evaporated during baking. The height (**Table 1**) did not appear to correlate to the flakiness of the products (**Figure 1**). Surprisingly in the blind taste testing, the panelists ranked Spectrum- All Vegetable Shortening with the highest liking scores in all five categories. However, when asked if they would consider substituting animal fat with any of the tested vegan products, the response averaged 2.8, a rating of unlikely to no opinion. No parameters were discussed for this question so it is possible that factors including cost, accessibility and lack of knowledge and experience in substituting new products in original recipes created bias. This resulting bias appears to have influenced the final consensus that, for these tasters, vegan fat substitutes are not acceptable.

References

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