Topic: How could we establish press time as a measuring agent to determine the quality of olive oil by titrating oleic acid in olive oil with KOH prepared in alcohol solution?

3707 words

Abstract

Olive oil is a product that we use in our everyday lives. It is beneficiary both for our immune system and the metabolism, preventing us from many serious illnesses such as cancer or Alzheimer's disease. Since it is a common household product, choosing the most healthy oil is crucial to our health. Not every product is fresh and 100% pure. In this essay, investigation was carried out to analyze the effect of time on the acidity of the olive oil through the research question: ***How could we establish press time as a measuring agent to determine the quality of olive oil by titrating oleic acid in olive oil with KOH prepared in alcohol solution?***

Oleic acid has many health benefits including reduction of cardiovascular diseases, cancer, Alzheimer's and many more. Because of the generous amount of fatty acids it contains, it can also be substituted for butter. However, although its is difficult, high heat can break the chains of the long hydrogen chains making it less beneficial to our health.

In the experiment two samples were left open, exposed to air and two were used straight out of the bottle with no wait. One of the main reasons why I used two different time periods is because there is a significant difference between the amounts of oleic acid due to oxidation. To determine the acidity of the samples, titration method was used and the values were monitored.

It is found that the samples that were exposed, tend to have a lower acidity than those ones which were straight out of the bottle. Therefore, making them less beneficial to our health. Similar to lower quality oils, exposed samples lacked the necessary antioxidants to qualify as a higher quality Extra Virgin Olive Oil. Regarding this information, I’ve concluded that it is best for olive oil to be stored in cool spaces with the lid closed for maximum use health benefits.

300 words

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1. Introduction

I've been dancing for fourteen years. As a dancer, it was important for me to maintain my diet and have a healthy body. That is why, ever since I was little, I always checked the list of ingredients in a packed snack, or the fat percentage of salmon etc. Recently, I noticed that one of the most common dressings that is used on salads is olive oil. I was curious on the effects of it on our body since we used it so much, so I attended conferences and oil tastings and learned quite a few things along the way. But I really wanted to learn the health benefits of olive oil if I were going to use it in my diet. So I decided to compare two samples of the same product, to see what the results might be. This experiment created the question ***"How could we establish press time as a measuring agent to determine the quality of olive oil by titrating oleic acid in olive oil with KOH prepared in alcohol solution?"***

One of our everyday products that we use at home is olive oil. There are many types of oils: virgin olive oils, extra virgin olive oils, pure olive oils and so on. But what makes a certain olive oil a good quality product? What should we depend on while choosing an oil while shopping in a supermarket? And how does time affect the shelf life of the oil? At this point, I started questioning whether or not I'm buying good quality oil and how can I determine that the product I've purchased is beneficial to my health. To find the difference, I chose a brand as my base and found samples of oils from the past and the most recent extraction.

2. Background Information

a. Olive oil: What is it and what makes it essential to our health?

Olive oil is the oil extracted from the fruit of the olive tree. The extraction process is fairly simple, crushing the olives until the juice comes out. But, it being so easy, in order to profit from the selling of the oil, the producers can tamper with the oil. For example, diluting it in older, cheaper oils or adding chemicals to preserve it.

The highest quality olive oil is *extra virgin olive oil.* It is made with traditional methods and is standardized by the smell and the color of the product. An extra virgin olive oil should have a color that is closer to green with a mixed smell of tomatoes, apples and red bell peppers. Real olive oil has a distinctive taste and is rich in phenolic antioxidants. When, tasted it should go smoothly through the mouth and leave a burn in the throat.

Olive oil has many beneficial traits. It contains fair amounts of Vitamin E and K and is filled with healthy fatty acids most of it being oleic acids. Aside from all the fats and vitamins, olive oil contains one of the most essential nutrients, *antioxidants*. These substances can help fight many diseases, therefore qualifying olive oil as a “superfood”.

Some of the antioxidants are anti-inflammatory. Inflammation is the leader of many critical illnesses such as heart diseases, cancer, metabolic syndrome, Alzheimer's and arthritis. It is believed that the antioxidants and fatty acids, mainly oleic acid, that are in the oil help reduce the effects of any crucial damage and relieves pain.

Olive oil is also considered to be a remedy against cardiovascular diseases which are the most common reason of death around the world. These diseases appear to be less occurring in the Mediterranean area, and most professionals believe that this is due to the amount of olive oil consumed in the Mediterranean

Diet. Extra virgin olive oil defends the body against heart diseases via numerous mechanisms:

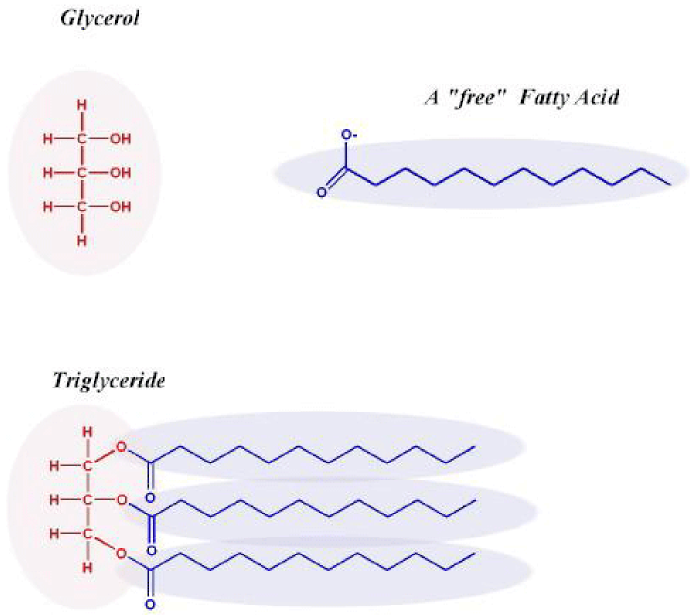
- Reduced Inflammation
- LDL Cholesterol
- Improves Endothelial Function
- Blood Clotting
- Lower Blood Pressure

It can also help prevent the effects of cancer and Alzheimer's disease.

b. The structure of olive oil

Olive oil is composed mainly of triacylglycerols, free fatty acids, and microscopic bits of olives. Triacylglycerols are the major energy reserve for plants and animals. These are molecules derived from the natural esterification of three fatty acid molecules with a glycerol molecule. The glycerol molecule can simply be seen as an "E-shaped" molecule, with hydrocarbon chains from about 14 to 24 carbon atoms in length.

Figure 1: Structure of olive oil and its components.



olive oil

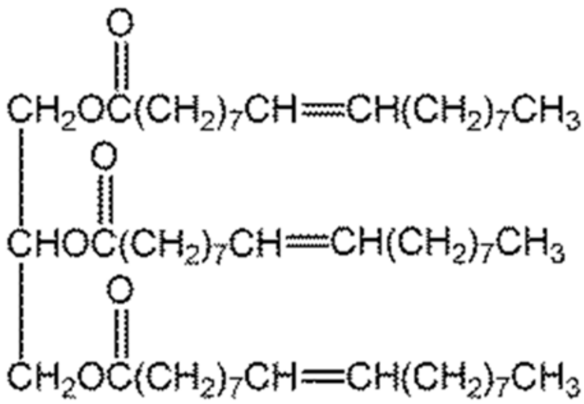


Figure 1: Top left: Glycerol, top right: FFA, bottom: Triglyceride, very bottom: olive oil.

FATTY ACIDS

Triacylglycerols are normally composed of a mixture of three fatty acids. Most common in olive oil is the oleic-oleic-oleic (OOO) triacylglycerol, followed by palmitic-oleic-oleic (POO), then oleic-oleic-linoleic (OOL) and so on.

The major fatty acids in olive oil triacylglycerols are:
Oleic Acid (C18:1), a monounsaturated omega-9 fatty acid. It makes up the half to 83% of olive oil.
Linoleic Acid (C18:2), a polyunsaturated omega-6 fatty acid that makes up about 3.5 to 21% of olive oil.
Palmitic Acid (C16:0), a saturated fatty acid that makes up 7.5 to 20% of olive oil.
Stearic Acid (C18:0), a saturated fatty acid that makes up 0.5 to 5% of olive oil.
Linolenic Acid (C18:3)(specifically alpha-Linolenic Acid), a polyunsaturated omega-3 fatty acid that makes up 0 to 1.5% of olive oil.

Olive oil contains more oleic acid than other vegetable oils. This means that the content of monounsaturated and polyunsaturated fats are also higher than other oils. This makes olive oil more durable against oxidation because the greater number of double bonds usually needs greater amount of heat for it to be broken down. That is the reason why olive oil from cooler regions have a higher quality. That is, a cool region olive oil may be more monounsaturated in content than a warm region oil.

Oleic acid has a structure with a hydrophilic end and a hydrophobic tail. Therefore it is polar but not that effective, making heating as a destructive agent rather than cooling, which is a preserver. Cooling the oil, not only preserves the flavor and the color, but also keeps the monosaturated structures intact, making it last longer. Heating however can be another situation. So while cooking, it is advised to heat up the oil until it started to smoke.

POLYPHENOLS (ANTIOXIDANTS)

Olive oil contains natural antioxidants called polyphenols that gives a bitter taste, astringency, and resistance to oxidation to the oil. They have a lot of beneficial effects such as healing sunburn or lowering cholesterol, blood pressure, and risk of coronary disease. There are as many as 5 mg of polyphenols in every 10 grams of olive oil whereas many other nut and seed oils have no polyphenols.

There are some factors that affect the percentage of polyphenols in olive oils:

-Time of Picking: Oil made from unripe olives has more polyphenols than oil made from ripe olives. The polyphenol concentration increases with fruit growth until the olives begin to turn purple and then begins to decrease. The perfect time for picking both to benefit from the quality and the health benefits is when a dark spot is beginning to form on the olive.

-Extraction Conditions: Is an olive contacts the ground or after picking is not immediately taken to pressing, then the polyphenol values drop drastically.

-Storage Conditions: The type of containers and the length of storing are key factors in the oil's polyphenol content. As oil sits in storage tanks or in a bottle, the polyphenols will slowly be oxidized and used up. Oils stored in stainless steel containers or dark glass bottles, in cool conditions, are much better protected against oxidation than those bottled in clear glass.

Oxidation is the process of electrons being transferred between molecules. When oils react with oxygen, it may be beneficial or non beneficial. While cooking the oil is oxidised and creating a bad taste, as labeled as "rancid". Oxygen atoms have six electrons, leaving two vacant slots to form either covalent bonds or hydrogen bonding.

c. The chemistry of oleic acid

Based on the amount of π bonds in fatty acids, the product can be classified as saturated and unsaturated. This is the reason why the structure also differ in length. As the number of bonds between two carbon atoms increase, length of bond decreases. As the bond becomes stronger, the carbon atoms come closer to each other.

Oleic acid is a monounsaturated omega-9 fatty acid that has a single double bond between carbon atoms in the chain. The remaining carbon atoms have single bonds between them. These kinds of fatty acids are liquid/semisolid/solid at room temperature and have a high melting point. Unlike saturated fatty acids their melting point is lower making it more difficult for them to melt. Oleic acid is commonly found in vegetable oils with a formula of; $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$.

π bonds are made out of two or more p orbitals overlapping on adjacent atoms. The carbon atoms, having double bond between each other, gather the hydrogen atoms on the same side of the double bond. Oleic acid shows cis-isomerism with polar structures, *cis* meaning on the same side. The geometry of the π bond between two sp^2-hybridized carbons forces them to be co-planar with the four attached substituent atoms.

The definition of *dihedral angle* is the degree π bond makes. So, dihedral angle in cis-isomerism is 0°. The force of the double bond locks its conformation and, causes the chain to bend and restricts the movement of the fatty acid. The process is the same as the number of double bond increases in the chain, the flexibility decreases meaning the structure will be more curved when the structure has many adjacent hydrogen bonds attached to the same side of double bond.

The Formula: $CH_3(CH_2)_7CH=CH(CH_2)_7COOH$

Figure 2: Structural Formula of Oleic acid

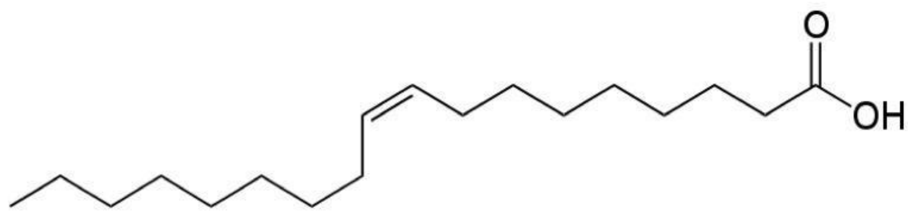


Figure 2: Skeletal-Chain structure of oleic acid $CH_3(CH_2)_7CH=CH(CH_2)_7COOH$

Figure 3: 3D Structural Formula of Oleic acid

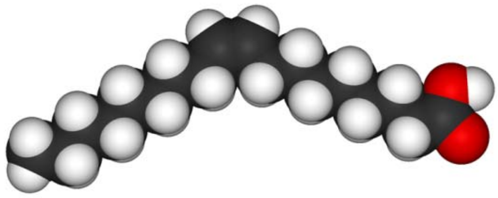


Figure 3: Skeletal-Chain structure of oleic acid $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$

IUPAC Name: (9*Z*)-Octadec-9-enoic acid

Other names: (9*Z*)-Octadecenoic acid

(*Z*)-Octadec-9-enoic acid

cis-9-Octadecenoic acid

cis-Δ^9-Octadecenoic acid

Oleic acid 18:1 cis-9

Molar mass: 282.4614 g/mol

Density: 0.895 g/mL

d. How is olive oil obtained?

The olive tree, or *olea europaea,* is largely found on the coast of the Mediterranean Sea. The fruit gathered from these trees, olives, are unique compared to the rest of the olives grown around the world. They contain a higher amount of oleic acid that is beneficial to the human body. Olive trees have been grown around the Mediterranean since the 8th millennium BC. Spain is by far the largest producer of olive oil, followed by Italy and Greece. The oil that has been obtained from Turkey is also one of the higher class oils made.

The process of turning olives into oil has been passed down from generation to generation and it is considered to be one of the most delicate art forms. To prepare the perfect oil, craftsmen should be very precise and delicate. Every step has to be completed to the dot, or else the quality of the product will not be as pure as expected. Each country has their own technique, but for the sake of simplicity, I have reviewed the method Turks use to make oil.

Making the liquid gold takes time and precision. There is a total of six steps that leads to the finished product: picking, cleaning the olives, grinding the olives into a paste, malaxing the paste, separating oil from the vegetable water and solids and the optional steps which include depitting, additives and additional processing. Steps on how to make olive oil is in the appendix.

e. Types of olive oils

The olive oil industry is a growing industry that is gaining value every day. Due to its increasing popularity, the quality of the products are determined via labels on the bottles. The quality of an oil is determined by the acidity. There are three kinds of oils:

1. Extra Virgin Olive Oil (EVOO)
2. Virgin Olive Oil (VOO)
3. Pure Olive Oil

1. Extra Virgin Olive Oil (EVOO)

Extra virgin olive oil is the highest quality and the most expensive oil amongst all three categories. Its qualities are fresh flavour and no defects. A good extra virgin olive oil has a bitter, fruity and a pungent taste. It is made with mechanical resources and is handled gently.

2. **Virgin Olive Oil (VOO)**

Virgin olive oil is made with the same process as extra virgin olive oil, except instead of slightly bruised olives, virgin olive oils are made with ripe olives, making it lower quality compared to extra virgin olive oil.

3. **Pure Olive Oil**

Also called "olive oil" is a mixture of refined olive oil and virgin olive oil. If the quality of the olive oil is not good enough to be called virgin or extra virgin, then it is refined and mixed in to make it smell better and taste better in order to be produced as "olive oil".

If a comparison is needed, these oils all have the same amount of calories and fat, except EVOO has a larger amount of healthy antioxidants compared to other oils.

3. Experimental Procedures

a. Methodology

Titration is the method used to determine precise endpoint of a reaction. The materials are a plastic or a glass burette, a erlenmeyer flask that contains the reaction, and a solution that will start the reaction in the burette. One of the reasons why I chose this method to find the exact point of the acidity level of the oleic acid is because the materials are easy to find in a school. Secondly acid base titration is the kind of experiment that requires either a strong acid or a strong base. Since I was working to find the oleic acid of the oil, I used KOH as my strong base. Before preparing my solution for titrating, I had to dissolve 14 grams of olive oil in 100 ml of ethanol to speed up the reaction. This means that ethanol acted as a catalyst in the reaction.

b. The experiment

In this experiment, I used four samples of two kinds of olive oil; 2014 press and 2016 press. The oils were from the same brand (Zetay) to minimise errors that could have come up if two different products were used. I prepared them with one half exposed to air for twenty four hours and another, directly out of the bottle. This way, comparing the oleic acid values became easier.

One mole of potassium hydroxide is 56.1 grams. I used 0.5 moles of potassium hydroxide which is 28.05 grams. To prepare my solution, I used 500.00 ml of n-propanol solution and added 28.05 grams of KOH. Since the reaction is exothermic, I made sure to stir the solution slowly in order to prevent any accidents. The reason behind me using n-propanol solution is, because KOH dissolves in n-propanol that makes it easier for it to react with olive oil. Otherwise, the reaction mixture produces a bulky appearance that makes it difficult to determine the endpoint.

I used *phenolphthalein* as an indicator for this experiment. Phenolphthalein has a pH value between 8.2 and 12, and is colorless below 8.2. Having a pH range between 8.2 and 12 means that anything in between would neutralise with the base and create an indicator. In this case, the original color, green, will be turned into pink. It changes color rapidly even with the smallest added molarity, even though it is not the right range of acidity. The correct range is determined when the color is constant for thirty seconds.

Aim: To determine the amount of KOH prepared in n-propanol solution needed to neutralise the oleic acid in the olive oil and observe the change in the amount of oleic acid due to the press time and storage conditions.

Hypothesis: The oleic acid in the new fresh 2016 press olive oil has more oleic acid and healthier than old press and exposed one will be less than the newer, fresher olive oil.

Constant values: Pressure of surroundings, lab conditions, lab equipments, mass of oil, type of indicator, amount of indicator, temperature, volume of ethanol, KOH solution prepared in n-propanol, kind of oil, color of the solution at the endpoint.

Independent variable(s): press time, amount of polyphenol, amount of oleic acid

Note that there are two parts to this experiment, first being comparison of press time and second, effects of storage conditions.

Dependent variable(s): The amount of KOH in n-propanol needed to neutralise the oleic acid in the oil.

Materials and the procedure can be found in the appendix.

Qualitative observations

During the procedure, as the drops of KOH solution increased, The color changed from green to pink, only to turn back to normal. The time where the color pink remained constant for thirty seconds or more, was the part where the pH value was determined.

Olive oil has a green color and smells like a mixture of tomatoes, peppers and apples. As press time passes and the oil is exposed to air, the color changes into a more yellow color and the smell fades. KOH creates an exothermic reaction that makes it difficult to be dissolved in n-propanol solution. Unless the solution is dissolved in ethanol, the color will not be pink, but rather red.

Figure5: Olive oil with added KOH solution.

Figure5: A sample of olive oil with the determined pH value.

4. Calculations

Table1:Exposed Bottle (Zetay, 2014 press)

Sample	Mass of oil (g±0.001)	Vused KOH in n-propanol (±0.05)
1	14.005g	27.21
2	14.003g	26.52
3	14.005g	23.52
4	14.009g	24.71

Table1: Mass of oil and the amount of titrant needed for each sample for exposed bottle of Zetay, old press

Table2:Fresh Bottle (Zetay, 2014 press)

Sample	Mass of oil (g±0.001)	Vused KOH in n-propanol (±0.05)
1	14.007g	29.12
2	14.006g	27.70
3	14.000g	27.50
4	14.003g	27.79
5	14.023g	27.53

Table2: Mass of oil and the amount of titrant needed for each sample for fresh bottle of Zetay, old press

Table3:Exposed Bottle (Zetay, 2016 press)

Sample	Mass of oil (g±0.001)	Vused KOH in n-propanol (±0.05)
1	14.005g	29.22
2	14.002g	31.21
3	14.000g	31.38
4	14.005g	34.18
5	14.001g	31.08

Table3: Mass of oil and the amount of titrant needed for each sample for exposed bottle of Zetay, new press

Table4:Fresh Bottle (Zetay, 2016press)

Sample	Mass of oil (g±0.001)	Vused KOH in n-propanol (±0.05)
1	14.008g	32.82
2	14.003g	31.72
3	14.004g	34.01
4	14.007g	30.03
5	14.003g	32.33

Table4: Mass of oil and the amount of titrant needed for each sample for fresh bottle of Zetay, new press

5. Processing of data

$CH_3(CH)_7CH=CH(CH)_7COOH+KOH \rightarrow CH_3(CH)_7CH=CH(CH)_7COOK+H_2O$

Mole of oleic acid = nKOH

Mass of oil in erlenmeyer flask =14.00±0.05g

One bottle of olive oil =500.00 ml→ 464.000g

Vused KOH in n-propanol = 27.21 ml ± 0.05ml

M_{KOH} = 0.50±0.05

T = (22.0± 0.5)□

MW oleic acid→282.4614g/mol

$n_{acid}=n_{base}$

$M_{acid}.V_{acid}=M_{base}.V_{base}$

$M \times V$ = n KOH = $n_{oleic\ acid}$

$(27.21 \pm 0.05)10^{-3}L(0.500.05)M$

$= (27.21\%18)10^{-3}(0.50\%10)$

$=n_{KOH}=10^{-3}$ x13%28 = noleic acid

$M_{oleic\ acid}$=noleic acidMWoleic acid

$=(13\%28)10^{-3}$mole282.4614g/mole

=3.7%28g

$m_{oil\ sample}$ = 14.005g ± 0.01 oil

m=3.7 ± %28g oleic acid

14.005g → 3.7g oleic acid

464.000g→ ?

=122.585 ± %28g of oleic acid in 500.00ml bottle

Table5: Exposed Bottle (Zetay, 2014 press)

Sample	Oleic acid in the sample	Oleic acid in 500 ml bottle (approx. 464.00g±0.01)
1	3.7%28g	122.58±34.32g
2	3.7%29g	122.58±35.55g
3	3.4%31g	112.64±34.92g
4	3.4%30g	112.64±33.79g

Table5: The amount of oleic acid in one sample of exposed oil (Zetay, old press)

Table6: Fresh Bottle (Zetay, 2014)

Sample	Oleic acid in the sample	Oleic acid in 500ml bottle
1	4.1%27g	136.14±36.75g
2	3.2%28g	106.01±29.68g
3	3.8%28g	125.94±35.26g
4	3.9%28g	129.21±36.17g
5	3.8%28g	125.73±35.20g

Table6: The amount of oleic acid in one sample of fresh oil (Zetay, old press)

Table7:Exposed Bottle (Zetay, 2016)

Sample	Oleic acid in the sample	Oleic acid in 500ml bottle
1	4.1%27g	136.72±36.91g
2	4.4%26g	146.06±37.97g
3	4.4%25g	146.82±36.70g
4	4.8%24g	159.93±38.38g
5	4.3%26g	145.46±37.81g

Table7: The amount of oleic acid in one sample of exposed oil (Zetay, new press)

Table8: Fresh Bottle (Zetay, 2016)

Sample	Oleic acid in the sample	Oleic acid in 500ml bottle
1	4.6%25g	153.53±38.38g
2	4.4%25g	148.39±37.09g

3	4.8%24g	159.14±38.19g
4	4.2%26g	140.49±36.52g
5	4.5%25g	151.49±37.87g

Table8: The amount of oleic acid in one sample of fresh oil (Zetay, new press)

6. Conclusion

Having concerns about my health lead me to prepare this experiment, using the same brand olive oil that has different press times as my samples. The effect of time on the product and the exposure to oxygen was the main subject in this extended essay, supporting my research question: ***"How could we establish press time as a measuring agent to determine the quality of olive oil by titrating oleic acid in olive oil with KOH prepared in alcohol solution?"***

The method I used was extremely efficient in determining the pH level of the oil, due to the acid-base reaction occurred in the flask. I used an n-propanol solution that included KOH, which neutralised with the acid and formed a pink color, indicating the level of acidity in the olive.

The amount changed however, both when I used different press times and also when they were exposed to oxygen. The reason behind this change is, when olive oil becomes in contact with oxygen, the polyphenols start oxidising, lowering the oleic acid. The process is the same, only a bit slower for the press time difference. The antioxidants oxidise, making the olive oil less acid.

To find the pH value of the product, I firstly decided to use the same brand to ensure that the steps of making the olive oil as similar as possible. Olive oil is a very sensitive dressing, the quality could be affected by the simplest external factors like a drop of water or dirt. That is why I chose a brand with a factory that I'm familiar with.

The process started with two sets of oils that had different press times, one from 2014, the other 2016. I prepared five samples to work on right away, and five to leave in contact with air for twenty four hours. With the first five samples, I dissolved each in 100 milliliters of ethanol, making them more available to react. The newest and most fresh olive oil was high in acid values, proving to have larger amounts of polyphenols. After twenty four hours, I pursued the same steps for the second set only to find that the pH levels are slightly lower than the first test. This was caused by the oxidation of the antioxidants in the oils. For the product with the older press date, I used the same procedures and got very similar results.

Table9: Calculated values and uncertainties.

Sample	Average	Uncertainty	%Uncertainty	%Error
1	3.6	±0.1	%2.8	%2.8
2	3.8	±0.2	%5.3	%7.9
3	4.4	±0.2	%4.5	%6.8
4	4.5	±0.1	%2.2	%2.2

Table9: Table showing the calculated and measured values from percentage error values with uncertainties.

There are many reasons why these errors could have occurred. These errors can be classified as systematic and random errors. Random errors can be found in the %uncertainty column on the table above. But, as we don’t have a literature value, average values were used to discuss systematic errors. When systematic and random errors were compared, there wasn’t a distinct difference between them that created a problem. One of the systematic errors in the experiment could have been caused because of the temperature of the room. As I have established earlier in the essay, the oil which is in a cooler space is more in oleic acid amounts than a sample in warmer conditions. During the 24-hour wait, anything could have tampered with the samples and interfered with their acidity.

Another reason could be the choice of indicator. Although phenolphthalein is a suitable choice for this experiment, pH probes can be used to identify the exact equivalence point from its graph. Another problem could be from the volatility of alcohol and olive oil. They might change the concentration of both oleic acid in the sample,and KOH. In addition, electronic heaters must be used to keep the temperature constant. Finally, it is better to compare to the color of the current sample with a controlled example.

My research was to find whether or not I should store olive oil in a place with low oxygen or just in an open container and if an old bottle has any negative effects on my health. I expected to find different polyphenol values between every set of samples and predicted that there might be a decrease in the amount of antioxidants. A seen on the table, the most fresh and the newest press had the most oleic acid value while the oldest and exposed sample had the least. The results of my experiment proved that indeed there is change when the oil is not used properly, but there aren’t any risks concerning my health and well being.

7. Evaluation and improvement

Although titration method is fairly easy to conduct due to the small number of materials and few steps, I still came across many obstacles during the process of this experiment. Firstly, I prepared the experiment without dissolving the olive oil in ethanol solution. This lead to incorrect readings because KOH didn’t react with olive oil, rather just phenolphthalein. In order to have rational results, I dissolve 7 grams of olive oil in 50 milliliters of ethanol solution. I doubled the amount of both the sample and the solution to decrease my error percentage.

For the first set of samples (Zetay, 2014 press exposed bottle) the first flask ended up not reacting, in a result using up all 50 milliliters of KOH solution. The reason for this error might be because of residue from a previous experiment or the sample could’ve been tampered with.

This experiment could be improved by using more accurate devices and less human help. Also in the olive oil industry, in order to check the acidity of the products, every year there could be a test made. This experiment can also be used as a critic for storage spaces. If the space has oxygen, then the olive oil will loose its antioxidants. Repeating the same experiment 2,4,6,8 hours at a time will help determine the quality of the storage area.

In addition to storage conditions, the experiment could be used to determine whether or not if a place is warm and/or cold enough to store olive oil. As I have concluded, olive oil on cooler regions tend to be better in quality when compared to olive oil in warmer regions. Therefore, finding the pH value and comparing it with other samples will help modify storage areas if needed.

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Appendix

Materials

- 500.0 ml (±0.2 ml) of N-propanol solution including 0.5 M KOH
- 20 Erlenmeyer flasks (separately for each trial-100 ml±10)
- Beaker (250 ml±25)
- 1 Glass Burette(50.0 ml±0.5)
- Phenolphthalein (25.0 ml±0.5/ 3-4 drops for each trial)
- 2 samples of olive oil, one fresh one open bottle(250.0 ml±0.5)
- Pipette (50.0 ml±0.2)
- Ethyl alcohol (100.0 ml±0.2) for each sample of oil
- IKA Magnetic stirrer and hot plate
- Precision scale
- Thermometer ± 0.5□

The following section is linked to the procedure of the experiment. Make sure to measure the temperature every 10 minutes to understand that the temperature is kept constant.

After each trial, compare the final color with the example sample:

1. Mix 0.5 moles of KOH in n-propanol solution.
2. While measuring the mass of the oil on the precision scale, neglect the mass of the burette, preventing any miscalculations.
3. Prepare a 50 ml solution of n-propanol in the glass burette. Use a glass burette to prevent the solution from getting into a reaction with the plastic.
4. After preparing the glass burette, pour 100 ml of ethyl alcohol into the

olive oil in the erlenmeyer flask

5. Use four drops of phenolphthalein for each sample as an indicator. For the first flask, drop the magnetic fish inside the container and placed it on the magnetic stirrer. Activate the stirrer narrow the stopcock, mixing the solution more efficiently.
6. As the color turns pink, wait until the solution returns to its original color.
7. Repeat procedure until the color remains intact for thirty seconds. Record the results.
8. Repeat the steps until go through all the five samples.
9. Prepare 10 flask that contain 14.000 grams of the 2014 press oil. Set five of the samples aside for twenty four hours. The color of this press is yellower than the more recent press, indicating that time affects the chemistry of olive oil.
10. Pour 100 ml of ethyl alcohol into the olive oils. Repeat the steps (2-6).
11. Set up a table including both the volume of one bottle of and KOH used.

Making of olive oil:

1. Picking

Traditionally, in order to collect olives that are suitable for the oil making, trees were shaken or beat to create a force that would destabilize and drop the olives.

However, because of the time spent on the collection of the fruit exceeded the time needed for the olives to stay fresh, the traditional method was replaced with a newer version. This method uses a specific machine that targets the branches of the trees, setting a vibration that helps drop the fruit. Olives are quite durable, unlike peaches or apples that would bruise if they hit the ground hard. That makes it easier to not spend too much time on the collection.

There are seven stages of ripeness for olives:

Figure 4: Maturity index of olives

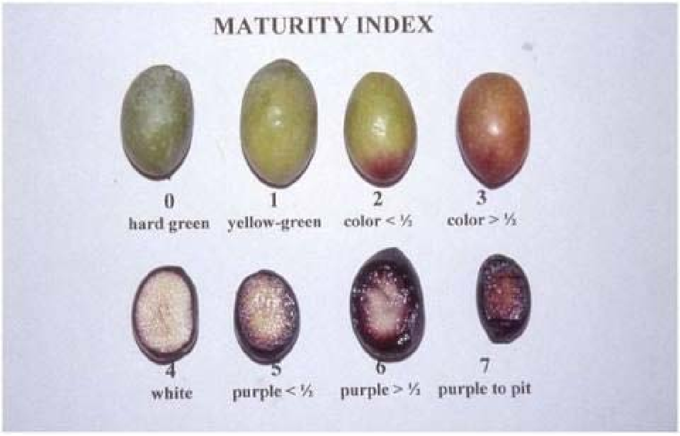

Figure 4: The effect of time on olives and their polyphenol values.

The ideal maturity of the oil should be between 1-3. As the color gets darker, the polyphenol value drops, making it useless. The largest amount of polyphenol is contained in the model marked as "0". The product of this model, due to the high level of polyphenol, would taste very acidic and would not be used in food related products such as dressings, but rather be used in the cosmetics area. Similarly, the model labeled as "7" would also be useless for the oil industry, because there is no polyphenol value left.

2. **Cleaning the olives**

After picking the olives, they are taken to the factory and the stems, leaves, any kind of bugs are removed. After the removal, the olives are washed to be cleaned from pesticides and dirt that might be on them. Any kind of rocks and sand is removed by soaking the olives in water.

3. **Grinding the olives into a paste**

The olives are crushed either in machines or stone millers and are turned into paste for easier processing.

4. **Malaxing the paste**

Mixing the paste allows small particles of oil come together and form bigger drops. The paste is heated and water is added to make it easier for the oil to be extracted. Although it is easier, this can lower the quality of the product.

5. **Sieveing**

This process is what gives the name “cold press” or “first press” to the oil. It separates the olive froms water and solids by centrifuges.