Determining Which Household Chemical is Most Effective in Decomposing Raw Chicken Thighs

Eleanor G. Bond

Department of Entomology, Texas A&M University

Editor: Abigail Ryan

Abstract: In crime scenes, humans will often choose chemicals to try and accelerate the process of decomposition. With this idea in mind, the purpose of this study was to determine which household chemicals are most effective in decomposing tissue, specifically raw chicken thighs. In considering which chemicals to choose, three criteria were established. First, a wide range of acids and bases were selected to reflect the spectrum of the pH scale. Second, the chemicals had to be easy to access or purchase without raising suspicion. Lastly, the household chemicals had to be inexpensive to obtain. For the acids tested, 3% hydrogen peroxide, 5% vinegar, and Lysol toilet bowl cleaner were chosen. To test the basic efficacy, Clorox bleach, Drano, and dairy lime were selected. A single piece of raw, boneless chicken thigh was placed in a glass jar and then covered with the individual chemical. The duration of the entire experiment was fourteen days. To measure the changes in both the solution and chicken, pH paper was used to assess the chemical changes. Additionally, the physical changes of the meat were examined for decomposition, or the breakdown of tissues. The data collected included the pH levels of the meat and solution, odor, buoyancy, and consistency of the muscle fibers. After fourteen days, the data was analyzed to determine what was most effective. It was concluded that the most effective household chemical was Lysol toilet bowl cleaner. The highly acidic solution lowered the pH of the meat the most, significantly degraded the consistency of the muscle fibers, and concealed the odor of decomposition the best.

Keywords: decomposition, chemicals, pH, raw chicken

To determine which chemicals will affect the rate of decomposition, or tissue breakdown, one has to consider what the average person can obtain and purchase with ease. Therefore, the chemicals selected were limited to common household items found in a supermarket setting. In choosing the chemicals to use, two criteria were considered. First, the solutions and powder had be easy to access, and second, they would have to be inexpensive to purchase. Any of the chosen household items can be bought directly off the shelf of most major supermarkets. Perhaps more importantly, these household items can also be purchased in bulk without arousing any suspicion. When selecting specific chemicals, a balance of acidic and basic chemicals is needed. Therefore, a large range of pH levels ranging from 1.5 to 12 were purchased to complete the experiment. Once the chemicals were identified, raw chicken thighs were obtained to use as the medium for decomposing meat. Acids react with the raw chicken through protein denaturation and the process of hydrolysis. Ultimately, this would break the protein bonds, release water, and eventually soften the meat. With bases, the decomposition process involves saponification, which is the breaking of fatty acid bonds in cell membranes. In this experiment, we were able to identify which chemicals were ineffective or effective in decomposing meat over a two-week period. Additionally, the experiment revealed how the composition of the meat is changed by each individual treatment based on its chemical composition. It is important to note that the household chemicals utilized are often diluted with water; therefore, they are not likely to be as effective as their more concentrated counterparts.

For this experiment, it was hypothesized that the chemical with the lowest pH and the highest acidity would be the most effective in decomposing raw chicken thighs over a two-week period.

Materials and Methods

Boneless chicken thighs were selected to mimic decomposition of flesh, and were stored in 900 mL glass Mason jars with the chemical treatments over the duration of two weeks. For the control, one glass jar contained only a piece of chicken thigh with no additional chemicals. The control was used to represent the decomposition of meat alone without any chemicals to speed the process. A balance of acids and bases were selected to give a full range of chemical representation during the decomposition process. The choices were limited to household items that are easily accessible to everyday people. The following six chemicals in total were chosen: Equate 3% hydrogen peroxide, Heinz Distilled White Vinegar 5% Acidity, and Lysol Lime and Rust toilet bowl cleaner. Since the hydrogen peroxide was diluted with water and only 3% concentrated, it is measured as a weak acid with a pH of 6. The vinegar was measured as a stronger acid with a 5% acetic acid concentration and a pH of 3. As the strongest measuring acid, Lysol toilet bowl cleaner tested with a pH of 1.5. The low pH was due to the 9.5% concentration of hydrochloric acid. For the bases, Clorox bleach, Drano Max Gel, and Dairy Barn Lime were selected. These chemicals also represented a basic range on the pH scale. The only solid in the list of chemicals was lime, which consisted of crushed limestone or calcium carbonate. Lime was chosen because it is a weak base (pH of 9) that would mimic decomposing flesh in a rocky environment. As a mid-range base, Clorox bleach contained at least 6% of sodium hypochlorite and measured 10 on the pH scale. With the highest pH of 13, Drano Max Gel was the strongest base and contained sodium hypochlorite and sodium hydroxide. The exact concentrations in Drano are unknown and remain a trade secret. With the exception of the Dairy Barn Lime, all chemicals and materials needed for the experiment were purchased at a local supermarket, Walmart. The lime was obtained at a farm and ranch store, Bomgaar's.

Using seven clean, glass Mason jars, 227 g of each chemical treatment were poured into one of the jars. The measuring cup used was washed between each chemical. The control jar had no chemical or liquid added to it. After the jars were filled, the pH levels were recorded using a pH indicator paper strip. The tips of the indicator strips were carefully submerged into each of the jars and immediately removed. Then, the color change on the paper was compared to the pH color scale shown on the pH package. Caution was used to keep the disposable gloves clean and free from exposure to the chemicals so that pH readings were accurate. Once all the pH strips were photographed on the paper plate, they were disposed of in the trash. A food scale was then used to measure the raw chicken as the decomposing matter. Each chicken thigh was placed on the scale to ensure it was at least 150 g in weight before being cut into pieces. This ensured that enough chicken thigh was available to sample into four pieces weighing 30 g each. To divide the chicken, both chicken thigh pieces were placed on a cutting board. With a chef's knife, the thighs were quartered into four equal-sized pieces each. Each individual piece was then placed on the food scale to ensure an exact weight of 30 g. If the weight was over 30 g, the meat was then sliced down incrementally and reweighed. Once the meat was measured at 30 grams, it was set aside on the cutting board for future use. Weighing and cutting the chicken thighs were repeated until there was enough for each treatment. Ultimately, there were seven equally weighted chicken thigh pieces at 30 g each. With fiberglass chopsticks, a piece of meat was picked up placed into each treatment jar. Carefully, the chicken thigh was put in the solution so that no splash occurred, and the chopsticks were not contaminated by the solution. Immediate observations were noted on how the chicken interacted with each chemical. For the control jar, a piece of chicken was placed in the empty jar with no chemicals. In the jar filled with lime, the chicken was placed last, since the chopsticks had to submerge the meat in the powder to cover it on all sides. The lids to the glass jars were then placed on top of the jars but not tightened. The jars were kept in a temperature-controlled room of 75 degrees Fahrenheit over the duration of two weeks.

To determine which household chemical was most effective in decomposing the chicken thigh pieces, a variety of observations and pH measurements were determined after 7 days and 14 days when the experiment ended. At the seven-day mark, only visible observations of both the chicken thigh and chemical were made, so as to not disrupt the process of decomposition. These observations were the following: color changes of both the chicken thigh and chemical, buoyancy of the meat, and consistency changes of the chicken thigh and chemical. After 14 days, the same visible observations were made similar to day seven, but additional measures were taken. These measures were the pH of the solution, pH of the meat, changes in the physical appearance of the meat and the solution, palpation of the chicken thigh, and resultant odor. To attain these objectives, a ceramic plate lined with a paper towel was set adjacent to the glass jars of chemicals and meat. Next, the lid was removed from the first solution tested, hydrogen peroxide. Using a pair of clean chopsticks, the chicken thigh was removed from the jar and placed on the paper towel on top of the ceramic plate. At this stage, the pH of both the meat and resultant chemical was recorded using a pH indicator strip. Furthermore, the chicken thigh was palpated by hand and with chopsticks to assess changes in the muscle fibers as well as physical changes of the meat. The resultant chemical in the glass jar was observed for physical changes, as well as its odor. To prevent contamination, both the chopsticks and the ceramic plate were washed with Dawn dish soap and warm water, then dried with a paper towel. This entire process was carefully repeated with the remaining five solutions: vinegar, Lysol toilet cleaner, Clorox bleach, Drano, and lime. The control group of the chicken thigh without a chemical solution had a different method of examination and data collection. The protocols were the same, but since no chemical was involved, all data and observations were for the meat alone.

Some of the observations recorded through the experiment were physical changes in both the solution and chicken thigh. These physical changes were the color and condition of the meat and solution. Additionally, the chicken thigh was palpated after two weeks to feel the consistency of the muscle fibers and which solutions degraded the protein best. More objective information was gathered by measuring the pH of the meat and chemicals at the end of the experiment. Observing the odor of both the chicken and solution also helped to determine which chemical concealed the decomposition best. By reviewing this information, a solution to the question of which household chemical was most effective in decomposition of chicken thighs was determined. This conclusion was based on pH levels and ultimately the condition and degradation of the chicken thigh meat.

Results

In determining the efficacy of decomposition of chicken thighs with household materials, data was collected at three separate times of the experiment: day one, day seven and finally at day fourteen.

On day one, only the pH of the solutions and chicken meat were taken. The most acidic solution was Lysol with an initial pH of 1.5. Additionally, the pH of vinegar was measured at 3 and the hydrogen peroxide was 6. The chicken meat control was also mildly acidic with a pH of 6. The most basic solution was Drano with a pH of 13. Clorox bleach was measured at a pH of 10, and Dairy Lime had a pH of 9. This data collected is reflected in Table 1.

Solution	**pH Level (Day 1)**
Hydrogen Peroxide	6

Vinegar	3
Lysol	1.5
Bleach	10
Drano	13
Lime	9
Chicken Thigh	6

Table 1. Day 1 pH Levels of Tested Chemicals

On day seven, observations included physical changes of both the solution and meat, buoyancy of the meat, and whether the meat had remained intact in one piece. In the hydrogen peroxide solution, the meat had undergone some blanching changes. The color of the meat had lightened to a light pink with some blanching at the edges. The hydrogen peroxide solution had become cloudy with a foamy white residue on top. The meat was buoyant, intact in one piece, and had only two small pieces of fat that had separated. In the jar containing vinegar, the chicken meat had completely blanched and was white in color. The solution had remained clear with no residue. Also, the chicken meat remained in one piece with no buoyant properties. The last acidic solution, Lysol toilet cleaner, was blue in color, therefore, it was difficult to perceive any color changes in the meat. However, the chicken had cleaved into two separate pieces at the bottom of the jar. The Lysol remained clear with no residue. For the basic Clorox bleach solution, the meat was light pink in color with mild blanching at the periphery. In the jar, the bleach solution was cloudy, and the chicken had remained intact in one piece with no buoyancy. In the jar containing the Drano solution, the chicken had a smooth texture with its pink color unchanged. There was no fat remaining on the piece of meat. The Drano solution was uniformly cloudy with a foamy top layer. White debris had also collected at the bottom of the glass jar. The meat remained intact in one piece, and was buoyant, floating at the top of the solution. For the Dairy Lime jar, there was very little change in the color or consistency of the meat. The lime itself remained unchanged, and the meat was in a singular intact piece. Finally, the chicken meat control underwent some physical changes such as browning in color at the edges. In the jar, a small amount of brown colored liquid also began to accumulate. The meat remained in one piece with no change in consistency. This data is consistent with the information presented in Table 2.

Table 2. Day 7 Observations

	Physical Changes in	**Physical Changes in**	**Intact?**	**Buoyancy**

	Meat	Solution		
Hydrogen Peroxide	Light pink center with mild blanching.	Cloudy, white, foamy residue on top.	Meat in one piece with a few fat pieces separated.	Yes
Vinegar	Meat totally blanched and white.	Mostly clear.	Meat in one piece.	No
Lysol	No change in color. Separation of meat.	Clear blue. No residue.	Meat in two pieces.	No
Bleach	Blanching on the edges. Rest is a light pink color.	Cloudy appearance, some residue.	Mostly intact, few small pieces floating around.	No
Drano	Smooth appearance, pink color, no fat.	Cloudy, foamy top layer. White debris at the bottom.	Intact, meat in one piece.	Yes
Lime	Very little change, pink in color.	No change.	Meat is intact.	N/A
Control	Mostly pink in color. Edges of the meat are browning.	Brown liquid/sludge accumulating around the chicken.	Meat is intact.	N/A

After fourteen days, data was collected again for final analysis, including the final pH of the chicken and solution, the consistency of the meat on palpation, and the odor of the remaining solution. In the glass jar with hydrogen peroxide, the final pH of the solution was 9 and the meat was measured at a 7. When the chicken was palpated for changes in the consistency, the muscle fibers remained relatively unchanged. The meat had turned grey in color, but ultimately was the only change in the meat. The remaining hydrogen peroxide solution was cloudy in color, and it had a very strong odor consistent with decomposition. The meat remained in one piece floating on top with very little fat particles separated. For the vinegar treatment, the pH of the solution was 5 and the pH of the chicken thigh was measured at 4. When the thigh was palpated, there was no change in the muscle fiber consistency and the fat remained intact. The most obvious physical change was only that the meat was white in color. There was a moderate odor to the vinegar solution, and the meat remained in one piece. The pH of the Lysol solution was 1, and the pH of the chicken thigh was 2. After removal from the solution, the chicken thigh had cleaved into two pieces. Through palpitation, the meat exhibited a soft, granular appearance. The muscle fibers had significantly degraded, and it was easy to break down the meat. The remaining Lysol solution was clear and without sediment. The Lysol did not develop an odor consistent with decomposition, and it remained the same as day one. For the basic solutions, Clorox bleach was first evaluated. The pH of both the solution and chicken meat was measured at 10. Physically, very little change occurred in the meat. It was still pink in color, and the muscle fibers showed no change when palpated. As for the bleach solution, it was cloudy and without sediment. The chicken remained intact in one piece, and the solution had a moderate decomposition odor. In the Drano glass jar, both the solution and chicken thigh measured a pH of 11. When the meat was removed from the solution, it remained in one piece, but the meat itself was orange in color and had a very smooth appearance. All remaining fat had disappeared. On palpation, the chicken thigh had become very tough and hard. The remaining Drano solution was murky, with foam and bubbles forming on the surface. For the Dairy Lime treatment, the remaining lime pH was 10 and the chicken was measured at a pH of 8. Little to no physical changes occurred to the chicken thigh, and it remained in one piece. There were no changes in the color of the meat, and on palpation, the muscle fibers and fat were the same consistency as day one. There was a very strong odor to the leftover lime in the glass jar. Finally, the control treatment chicken thigh had a pH of 8. Physically, the chicken thigh was brown in color and very glutinous. It remained intact in one piece, and emitted a very strong odor of decomposition.

These observations are represented accurately in Table 3. Additionally, comparative changes in pH levels for both the solutions and the meat are reflected in Table 4. Resultative conclusions are made in Table 5, showing if a particular substance became more acidic or basic over the course of the 14-day period.

Table 3. Day 14 Observations

	Solution pH	**Meat pH**	**Buoyancy**	**Consistency of meat on palpation**	**Physical change of solution**	**Odor**	**Pieces?**
H_2O_2	9	7	Yes	Similar. Did not break down muscle fibers. Grey colored.	Very little fat floating. Cloudy solution.	Strong odor.	None. Fat stayed attached
Vinegar	5	4	No	White, blanched meat. No muscle fiber breakdown. Fat mostly intact. “Preserved meat.”	Mostly clear with 2 small fat pieces floating.	Moderate odor.	Meat stayed in one piece.

Lysol	1	2	No	Meat was easily degraded. Granular in appearance. Very soft upon palpation. Crumbly consistency.	No change in color. Mostly clear solution with no sediment.	None, Lysol smell concealed scent.	Two separate pieces cleaved.
Bleach	10	10	No	Very little change. Fat remained with no degradation of meat. Very mild color change (pink).	Cloudy. No sediment.	Mild odor change.	Meat stayed in one piece.
Drano	11	11	Yes	Tough meat with no fat. Bright orange color. Degraded fat but no degraded muscle.	Murky/soapy solution. Foam and bubbles on the surface.	Mild odor.	No fat, meat in one piece.
Lime	10	8	N/A	Little to no change in composition. Almost preserved. Minimal color changes of pink.	No change.	Very strong odor.	One piece of meat, largely intact.
Control	8	8	N/A	Meat softened and turned dark brown. Slimy with sludge on the surface.	N/A	Very strong odor.	Meat in one piece.

Table 4. Solutions and Meat's Change in pH Over a 14 Day Period

	pH Day 1	**Solution pH Day 14**	**Meat pH Day 14**
Hydrogen Peroxide	6	9	7
Vinegar	3	5	4
Lysol	1.5	1	2
Bleach	10	10	10

Drano	13	11	11
Lime	9	10	8
Chicken Thigh	6	N/A	8

Table 5. Resulted Δ in Overall pH Levels on Day 14

	Solution Δ in pH	**Meat Δ in pH**	**Results**
Hydrogen Peroxide	↑ 3 pH	↑ 1 pH	Solution: more basic Meat: more basic
Vinegar	↑ 2 pH	↓ 2 pH	Solution: more basic Meat: more acidic
Lysol	↓ 0.5 pH	↓ 4 pH	Solution: more acidic Meat: more acidic
Bleach	No Δ	↑ 4 pH	Solution: no Δ Meat: more basic
Drano	↓ 2 pH	↑ 5 pH	Solution: more acidic Meat: more basic
Lime	↑ 1 pH	↑ 2 pH	Solution: more basic Meat: more basic
Chicken Thigh	N/A	↑ 2 pH	Solution: N/A Meat: more basic

Discussion

This study supported that the strongest acid and base were most effective in accelerating the decomposition of the chicken thigh. The results supported and were consistent with the initial hypothesis. Over a period of fourteen days, strong acids altered muscle fibers the most. The acid completed the acceleration through a process of denaturing the proteins in the muscle fibers. As a result, the meat became crumbly and brittle in texture. The strong base, Drano, also altered the chicken thigh significantly. Ultimately, there was no remaining fat on the chicken thigh after two weeks, and the meat had become very tough and shiny. The Drano also had a layer of foam on top of the solution, very similar to soap. This observation was consistent with the process of saponification. When the strong basic solution interacts with the meat, it underwent the process of alkaline hydrolysis. Once that occurred, the fatty acids and lipids broke down into soap and alcohol. As expected, the mid-range pH solutions were not effective in decomposing the muscle fibers of the chicken thigh, due to a lack in extremity of pH. All of the mid-range pH solutions (hydrogen peroxide, vinegar, bleach, and lime) exhibited physical changes to the meat, but did not alter its consistency. One of the limitations of this experiment would be the overall duration of it. The results could be different if a longer period of time was allowed for the chemical reactions. Additionally, a small sample size of solutions was chosen. Other strong acids or bases may be even more effective when tested. It is also important to note that only one series of data was taken, and results would be more reliable if the test was repeated for consistency and accuracy. For future studies, selecting a piece of chicken with the bone included could help to determine changes in skeletal structure in addition to tissue and muscle composition.

Acknowledgements

I would like to extend a thank you to Dr. Adrienne Brundage for always encouraging her students to fulfill and excel in their academic pursuits. I thank her for extending her love and knowledge of forensics to entry-level students both in and out of the classroom. I would also like to thank the Texas A&M University Libraries for granting me the necessary resources and applications for my research.

References

Campobasso, C. P., G. Di Vella, and F. Introna. 2001. Factors affecting decomposition and Diptera colonization. Forensic Science International. 120: 18–27.

Dent, B. B., S. L. Forbes, and B. H. Stuart. 2004. Review of human decomposition processes in soil. Environmental Geology. 45: 576–585.

Ioan, B. G., C. Manea, B. Hanganu, L. Statescu, L. Gheuca Solovastru, and I. Manoilescu. 2017. The chemistry decomposition in human corpses. Revista de Chimie. 68: 1352–1356.

Janaway, R. C., S. L. Percival, and A. S. Wilson. 2009. Decomposition of human remains. Microbiology and Aging. 313–334.

Klais, O. 1993. Hydrogen peroxide decomposition in the presence of organic material. Thermochimica Acta. 225: 213–222.

Schotsmans, E. M., and W. V. de Voorde. 2017. Concealing the crime: The effects of chemicals on human tissues. Taphonomy of Human Remains: Forensic Analysis of the Dead and the Depositional Environment. 1: 335–351.

Stuart, B. H., and M. Ueland. 2017. Decomposition in aquatic environments. Taphonomy of Human Remains: Forensic Analysis of the Dead and the Depositional Environment. 1: 235–250.

Taylor, L. S., A. Gonzalez, M. E. Essington, S. C. Lenaghan, C. N. Stewart, A. Z. Mundorff, D. W. Steadman, and J. M. DeBruyn. 2023. Soil elemental changes during human decomposition. PLOS ONE. 18.

Vass, A. A. 2001. Beyond the grave - understanding human decomposition. Microbiology Today. 28: 190–192.

Zhou, C., and R. W. Byard. 2011. Factors and processes causing accelerated decomposition in human cadavers – an overview. Journal of Forensic and Legal Medicine. 18: 6–9.