Chapter 6: Conclusions and Suggestions for Future Research

Development of emulsion coatings using hydrocolloids and partially hydrogenated fats resulted in three acceptable coatings. Incorporation of hydrocolloids into lipid bases, a modification to previous research (Ball, 1997), aided in coating application. Incorporation of hydrocolloids also reduced coating density, which may have been beneficial in preventing the peppers from shifting into anaerobic metabolism due to the complete exclusion of oxygen. Despite the application benefits, no differences between the three coating treatments were seen with respect to green pepper quality preservation.

The main differences in coating performance were observed in coating durability during changes in temperature. When peppers were removed from refrigerated storage condensation droplets that formed on the surface of the fruit resulted in a sticky surface texture. The stickiness was most often observed with the maltodextrin coated peppers. For this reason, coatings with a higher lipid content, which resisted moisture degradation, including the xanthan gum and locust bean gum coating, maintained integrity longer during storage. However, of the three coatings, the appearance of the maltodextrin coated peppers was shinier and more attractive than the other two coatings, which appeared duller on the fruit's surface. Therefore, recommendations for coating improvements include both improving moisture resistance and integrity maintenance of the maltodextrin coating, and improving the shine and reducing the haze of the other two coatings, while still maintaining their moisture resistant durability. These improvements could include increasing the lipid content of the maltodextrin coating to increase its resistance to moisture. Locust bean gum and xanthan coatings may be improved by changing the type of lipid used. The solid nature of the fat used played a role in the hazy appearance of the coating. Future modifications may include using more than one type of lipid, including use of a lipid liquid at room temperature to prevent the dull appearance generated by the solid fat.

Edible coatings, regardless of formulation, predominately preserved textural characteristics of green peppers. Peppers that were coated with any of the three

treatments had less moisture loss when compared with uncoated control peppers. The prevention of moisture loss alone is a major advantage of coating this type of fruit, because weight loss is the primary reason pepper fruits become unsuitable for sale. Moisture loss rates were less for all coated peppers regardless of formulation. The coatings with higher lipid content were expected to have superior moisture barrier properties. However, the maltodextrin coated peppers, which had a lower lipid content, displayed similar protective benefits. The high dextrin solid content of maltodextrin was believed to be responsible for the coating's moisture barrier properties

Other textural changes included increased breakdown of pectin in uncoated groups compared with less degradation in coated groups. Again, the type of coating was not important, but the action of physically providing a barrier was beneficial. The type of barrier may have inhibited pectin-degrading enzymes, including polygalacturonases, by reducing the rate of metabolic processes that induce these enzymes during senescence.

Despite the benefits of improved water retention and decreased pectin breakdown, no clear differences were seen in puncture force required to penetrate the fruits. The lack of difference may be attributed to a miniscule amount of textural loss, which was magnified when determining pectin changes during storage, or simply the inadequacy of the test. Future objective testing of puncture force may require using a different type of instrument and probe. For example, other instruments including the Texture Analyzer (Texture Technologies, New York NY) utilize a needle like probe to determine puncture force, as opposed to the cylindrical probe used in this research. Other tests have measured the overall force applied during the whole penetration process instead of measuring only the highest force used to break the fruit wall.

Edible coatings offered little protective effects against color degradation as measured by chlorophyll content, hue angles and chroma values. The lack of differences that were observed between coated and uncoated treatments was underscored by the lack of change in color as measured by the same tests during the storage period. Chlorophyll was not

found to be appreciably broken down, which indicated a lack of enzymatic breakdown by chlorophyllase and lack of photodegradation.

The lack of color change during storage indicated that green pigments in peppers may be relatively stable, and preservation of this characteristic may not be necessary. Some differences in chroma values were observed between treatments. In particular, the maltodextrin coated peppers were found to be significantly duller in color. However, the statistical significance was not practically important in terms of actual chroma values.

Ascorbic acid content did decrease during the study indicating that vitamin loss may have been occurring. However, after initial losses, content appeared to increase in the last two weeks of the study. This pattern of decreased levels in the first three weeks, and increased levels in the last two weeks was also observed in the dehydroascorbic acid data. In theory, as the amount of ascorbic acid decreases the amount of dehydroascorbic acid should increase. However, a concurrent increase in the oxidative degradation product, dehydroascorbic acid, did not occur. The diminished ascorbic acid values observed in the third week of the study were not expected, nor could they be attributed to any laboratory error. Future studies should repeat this testing to determine whether this is the true pattern of ascorbic acid oxidation.

Dehydroascorbic acid was significantly higher in uncoated groups of peppers, which may be an indication of increased ascorbic acid breakdown, although this was not confirmed in this study. Despite the lack of correlation between ascorbic acid and dehydroascorbic acid, it is still possible that ascorbic acid was being oxidized. However, this oxidation may have been masked by continued synthesis of ascorbic acid during storage. It is also possible that the dehydroascorbic acid was being reduced back into ascorbic acid. The reduction of dehydroascorbic acid into ascorbic acid could have accounted for the lack of loss observed in ascorbic acid. Dehydroascrobic acid may also have been continually broken down into other degradation products, including diketogulonic acid and oxalic acid, which would explain the observed decline in dehydrascorbic acid levels.

Respiration, as an overall indicator of senescence, did not reveal that the coatings afforded any decrease in respiratory processes. Respiration rates did increase dramatically over time, which may have been caused by water loss, handling stress, or chilling injury. Normally, increases in respiration rates of this magnitude occur only in climateric vegetables, which the green pepper is not. The fact that the coatings did not appear to reduce respiration, even in the event that the peppers were injured, disproves the hypothesis that edible coatings in this case acted to provide a modified atmosphere.

Future research suggestions include increasing sample size for respiration rates analysis and polygalacturonic acid analysis. In this study, the results of these two tests needed to be manipulated into log values due to the lack of underlying homegeneity of variance seen in the raw data. A larger sample size may eliminate the need to manipulate the data in order to establish homogeneity of variance.

In addition to repeating the ascorbic acid analysis, additional analysis of the components of ascorbic acid degradation would also be helpful. Oxalic acid and diketogulonic acid, both breakdown products of dehydroascorbic acid, should be measured to determine whether or not dehydroascorbic acid is breaking down or being reduced back into the ascorbic acid form.

Because relative humidity and temperature may have affected respiration rates of the peppers both of these factors should be closely monitored in future studies. Temperature control and humidity levels should be maintained to prevent chilling injury and stress from water loss. Humidity was difficult to control in this study due to the nature of the refrigeration units used. In future studies more controlled environments with higher humidity levels would be beneficial.

Lastly, future research should examine the role of microorganisms in spoilage of stored pepper fruits. Bacteria that cause soft rot, one of the most common types of decay in fruits, include *Erwina* and *Pseudomonas* species (Bartz and Eckert, 1987). The effect of coating application on proliferation and spoilage caused by these bacteria could be of

interest. In addition to spoilage bacteria, the effect of coating application on survival and growth of certain pathogenic bacteria may also be relevant. For example, *Listeria monocytogenes* is readily found on fresh fruits and vegetables. The application of a coating may trap these bacteria and provide a favorable environment for them to prosper. In addition, *Listeria* is capable of growing slowly at refrigeration temperatures, and if *Listeria* does grow, it is possible that the pepper fruits may not receive a cooking treatment to destroy the bacteria prior to consumption.

Appendix A- Sensory Panel Informed Consent Form

Virginia Polytechnic Institute and State University
Informed Consent for Participation in Sensory Evaluation

Title of Project: "Development of an Edible Coating for Preservation of Quality Characteristics of Green Bell Peppers."

Principal Investigators: Jennifer Ball, Graduate Assistant
Frank Conforti, Ph.D.

1. Purpose of the Project

The purpose of this project is to determine consumer preference of edible coatings applied to green bell peppers. Researchers in the Department of Human Nutrition, Foods, and Exercise are conducting this project. You are invited to participate in this project. Your participation is voluntary.

I. Procedures

As a participant you will be asked to first observe the appearance of four pepper samples. You will then be asked to rank these samples according to your preference for their appearance. Next, you will be asked to taste the four samples. After tasting the samples you will be asked to rank the samples in order of your preference for their taste. The test will take approximately 5 minutes to complete.

III. Risks

You will be tasting green bell peppers which have been coated with various food ingredients. The coatings you will be tasting are made from hydrogenated vegetable fats, food grade gums, starch derivatives, as well as other polysaccharides. All of these coatings materials have been approved by the Food and Drug Administration, so there are no risks involved provided you do not have any unknown allergies. Please list any allergies or other pertinent information at the bottom of this page.

II. Benefits

Your participation in this study will enable the researchers to determine which coating materials are acceptable to consumers. The acceptable coatings will be used in further research studies aimed at preservation of quality attributes of fruits and vegetables. You may receive the results or summary of the panel when the project is complete. Your participation is voluntary, and no guarantee of benefits can be made.

IV. Extent of Anonymity and Confidentiality

Information that you provide will be kept strictly confidential. Only code numbers will be used during the analyses of the scorecards and any written reports of the project.

2. Compensation

No compensation will be provided for subjects involved in this study.

VII. Freedom to Withdraw

Although it is important to the project that you complete the scorecard, you have the right to refuse to answer any of the questions that are asked.

VIII. Approval of Research

This project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University and by the human subject review of the Department of Human Nutrition, Foods, and Exercise.

IX. Subject's Responsibilities

I voluntarily agree to participate in this study which will require that I taste samples of green peppers and complete a scorecard.

X. Subject's Permission

I have read through and understand the Informed Consent Form and conditions of this project. I have been given the opportunity to ask questions regarding the project, and I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

Signature_____________________________________ Date ________________

Should I have any questions regarding the project or its conduct, I should contact:

Jennifer Ball
Principal Investigator
Department of Human Nutrition, Foods, and Exercise
Virginia Tech
540-231-7881

Dr. Frank Conforti
Faculty Advisor
Department of Human Nutrition, Foods, and Exercise
Virginia Tech
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H. T. Hurd
Director of Sponsored Programs
301 Burress Hall
Virginia Tech
540-231-5281

Please detach and keep this page.

Appendix B-Sensory Testing Ranking Scorecard

Scorecard Number_____

Directions:

Observe the **outside appearance** of the four pepper samples in front of you. Rank the samples (using their three-digit numbers) in the order of your preference for how the samples look. Designate the first sample as the sample that you prefer the most, and the last sample as the one you prefer the least.

1. ________ (preferred most)
2. ________
3. ________
4. ________ (preferred least)

After you have rated the samples in terms of appearance, please **taste** each sample in the order they are presented. Again rank the samples in order of your preference for their **taste** using the three digit numbers.

1. _______ (preferred most)
2. _______
3. _______
4. _______ (preferred least)

Appendix C - Puncture Force Analysis

1. Sample Preparation

Obtain 9 random peppers from each experimental group (36 peppers total). On a cutting board cut 2 side wall pieces (30 x 50 mm) from each pepper for duplicate measures. Avoid overly curved sections. In total 72 pieces will be sampled, 18 from each experimental group.

2. Instron Procedure

1. Turn on the Instron power button, computer, monitor, and printer. After the computer runs through a series of checks the main menu should appear on the computer.
2. Turn the GPIB button until the red light above it is lit. This enables the GPIB to interface with the computer.
3. Using the mouse, choose the section labeled "TEST" Test a Sample.
4. Fill in the information that appears on the screen: Operator (enter your last name), Sample ID (enter sample code), Method (enter "compressive"), and Method number 20. Method 20 is a preprogrammed method stored on this computer that runs the puncture test described in the materials and methods section of this dissertation.
5. Check parameters describing sample, change if necessary. If correct press F10 (ok).
6. Place the sample under the puncture probe assembly (stainless steel probe (0.50 mm diameter), and puncture platform.
7. Adjust the plate distance by turning off the GPIB button and using the up and down buttons. Turn the GPIB back on before starting the test.
8. Press enter to begin acquisition. The probe will move down at a rate of 100 mm/minute until it passes 2.5 cm through the sample. After the probe has reached its final distance the computer screen will read "remove the sample and press enter to return the cross head."
9. Place the next sample on the platform, press F10 to continue, and F10 again for "ok", and then hit enter to begin acquisition again.

10. Repeat for remaining samples. Press ESC to print data.

Appendix D – Pectin Analysis

Uronic Acid Extraction

1. Randomly select 36 pepper fruit, 9 from each treatment.
2. Separate the 9 fruits into 3 groups of 3 peppers.
3. Completely chop the 3 peppers and mix pieces to form a homogeneous sample.
4. Weigh out 8 grams of pepper pieces into a 50ml teflon tube. Homogenize the pieces in 20 ml of cold acetone (-20°C) for 2 minutes at maximum speed.
5. Filter homogenate with a glass fiber filter to retain the residue. Rinse the residue in the tube with an additional 20 ml of cold acetone (-20°C). Use a vacuum to pull liquid through the filter paper.
6. Wash the homogenate with 100 ml of 80% acetone and then repeat the washing step with 100ml of pure acetone. Do this by pouring the liquid over the residue retained by the glass filter paper and using a vacuum flask to pull liquid through the filter paper.
7. Re-suspend the insoluble material in 20ml of cold (4°C) 2 phenol:1 acetic acid: 1 water for 5 minutes to inactivate endogenous enzymes. Add acetone to a final concentration of 80% by bringing the liquid to 100 ml total volume in a volumetric flask.
8. Filter the insoluble acetone material through a glass fiber filter and dry at room temperature. Store powder in a glass petri dish in a vacuum desiccator over phosphorous pentoxide (Fisher Scientific, Fairlawn, NJ).
9. Place 40 mg of the dried acetone powder in a glass micro vial. Add 3 ml acetate-EDTA buffer (50mM Sodium Acetate, 40mM EDTA, pH 4.5). Stir powder and buffer with a magnetic stir bar at room temperature for 4 hours.
10. Centrifuge the suspension at 2500 rpm at room temperature for 10 minutes.
11. Remove 200µl for analysis.

Quantification Procedure

1. For each sample remove 200µl fluid from the micro vial samples. Add the fluid to a test tube. For a blank add 200µl acetate-EDTA buffer to a tube.
2. Prepare standard solution of polygalacturonic acid in a range of 0.25-20µg for the standard curve. Use at least 5 standards.
3. Add 1.2 ml of sulfuric acid/tetraborate (0.125M tetraborate in concentrated sulfuric acid).
4. Mix tubes by vortexing.
5. Cool tubes in a crushed ice bath.
6. Heat tubes at 100°C for 5 minutes.
7. Cool tubes in a crushed ice bath.
8. Add 20µl of m-hydroxydiphenyl reagent (0.15% metahydroxydiphenyl in 0.5% NaOH) to all of the tubes except the blank. To the blank add 20 µl of 0.5% NaOH without m-hydroxydiphenyl.
9. Mix by vortexing.
10. Read the absorbence at 520 nm on a spectrophotometer at exactly 5 minutes using micro-disposable cuvettes.
11. Using the absorbency values obtained for the standards, plot a standard curve. Read unknown concentrations by plugging their absorbency readings into the standard curve. A sample standard curve can be seen in Figure D.1.

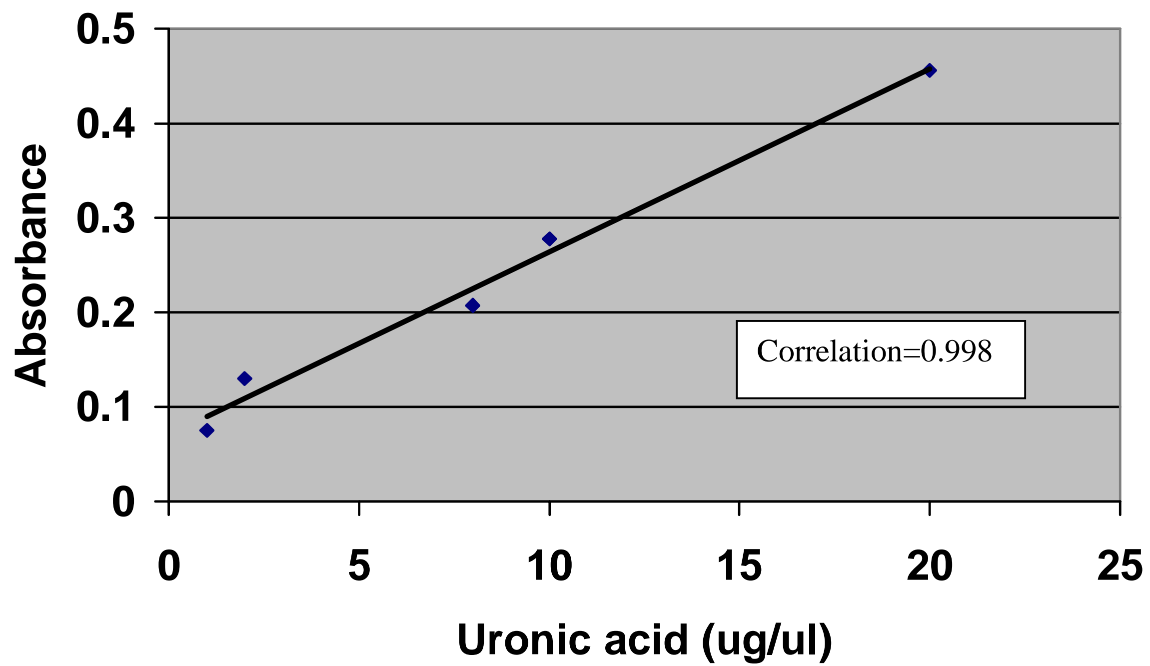

Figure D.1: Uronic acid standard curve.

Appendix E - Surface Color Analysis

1. Sample Preparation

Obtain 9 random peppers from each experimental group (36 peppers total). On a cutting board cut 2 side wall pieces (30 x 50 mm) from each pepper for duplicate measures. Avoid overly curved sections. In total 72 pieces will be sampled, 18 from each experimental group.

2. Hunter Colorimeter Method

1. Obtain laptop computer from the cabinet in Room 337, Wallace Hall.
2. Connect laptop cables (power supply, printer cable and DC power supply cable).
3. Connect the power cord to the sensory interface unit (SIU). Leave the SIU in the standby position until you are ready to run samples. The system will need to warm up for 30 minutes.
4. Turn the power on to the computer and printer.
5. Place the SIU in operate mode.
6. Follow computer instructions for zeroing the machine.
7. Place the black tile under the specimen port and press F1 (read).
8. Place the white tile under the specimen port and press F1 (read). The instrument is now zeroed and should be in the measurement mode.
9. Read cut samples (30 X 50 mm) by placing them in the specimen port, external side up.
10. Record L*, a*, and b* values.
11. Repeat with remaining samples.

Appendix F-Chlorophyll Analysis

1. Turn on Milton Roy Spectrophotometer.
2. Randomly select 36 pepper fruit, 9 from each treatment.
3. Separate the 9 fruits into 3 groups of 3 peppers.
4. Remove skin samples from 3 peppers, cut skin pieces into small fragments, mix fragments thoroughly.
5. Combine skin samples into a 1-gram sample.
6. Place 1 gram sample of pepper skin and place in a teflon centrifuge tube.
7. Add 15 ml cold acetone to the powder and homogenize until pieces are well ground.
8. Centrifuge samples for 10 minutes at 5000g.
9. Pour supernatant into a graduated cylinders suitable for holding 30 ml of liquid
10. Re-extract pigment from the pellet by adding 5 ml aliquots of 80% acetone and centrifuging.
11. Combine all extracts, adjust final volume to 30 ml.
12. Centrifuge combined extracts at 5000g for 10 minutes.
13. Read absorbance in glass cuvettes, at 645 and 663 nm.
14. Calculate chlorophyll content according to the following equation:

Total chlorophyll (mg/l) = $20.2D_{645} + 8.02\ D_{663}$

Appendix G - Ascorbic Acid and Dehydroascorbic Acid Analysis

1. Extraction of Ascorbic Acid and Dehydroascorbic Acid

3. Obtain 36 peppers from refrigerated storage (9 peppers from each treatment group)
4. Separate the 9 peppers from each treatment into three groups of three fruits. Each group of three peppers are then combined into a composite sample for testing. (Three groups of three peppers will be prepared for each treatment)
5. Completely chop all three peppers and mix the chopped sections thoroughly.
6. Weigh 25g of the cut pepper pieces into the blender,
7. Cover pieces with 50 ml of 3% citric acid.
8. Add 2 drops of antifoam agent (Antifoam A-5758, Sigma Chemical Co., St. Louis Mo.)
9. Blend for 2 minutes on the "blend" setting.
10. Pour samples into 100ml volumetric flask. Rinse residue into flask with 3% citric acid.
11. Bring homogenate up to volume using more citric acid.
12. Repeat steps 1-9 with remaining samples.

2. Solid Phase Extraction

1. Hook vacuum hose to filtration apparatus.
2. Attach filtration cartridges and collection tubes with holes in the bottom.
3. Turn on vacuum pump.
4. Pipette 4 ml of methanol into each filtration cartridge; allow to run through cartridge.
5. Pipette 4 ml of HPLC grade water through each cartridge; allow to run through. Repeat with 4 more ml of HPLC water.
6. Shake homogenate in volumetric to thoroughly mix. Pour 3 ml of homogenate into cartridges allow to run through. Some stirring with a glass rod or spatula may aid filtration.

7. Break vacuum seal; add collection tube inserts for collecting the remaining material collected.
8. Pour approximately 1 ml of homogenate into the cartridge; allow to collect in tubes.
9. Remove collected fluid, save for HPLC analysis.

3. Preparing and Loading HPLC Chromatograph and Autosampler

1. Turn on the Helium and Nitrogen Gases
2. Turn on computer, printer, controller, detectors and autosampler. If detector says "fail" press "auto zero." Wait for the (cal) light to go off on the UV detector. This indicates that the detector is calibrated.
3. On the controller press (set-up). From this screen press (system config). Scan the system by pressing (rescan). The following configuration should appear UV #1 484, 21; Autoinjector 712,5.
4. Press (set-up) to return to the main menu page of the controller. Press (Direct).
5. Place solvent lines in the appropriate solvents, one is the delivery line the other the sparge line. Let solvents purge for at least 30 minutes at 100 ml/min. Set this under the sparge section of the menu pages. Do not set any flow at this time, flow should =0 ml/min.

Acetonitrile/water (70:30) –use Optima HPLC solvents containing 0.01M Ammonium Dihydrogen Phosphate. Adjust to pH 4.3 with orthophosphoric acid.

6. At the computer, type in (Base) at the C>. The computer will ask if it is okay to delete files, answer: YES. Next, the computer will ask if it should initialize the plotter? Answer: NO.
7. Baseline should appear on the screen, press enter.
8. From the Main Menu Page on the computer, select "load a method". If the ascorbic acid method does not automatically appear you will have to load the method. For ascorbic acid load method C:Max\Data3, for dehydroascorbic acid load method C:Max\Data5.
9. Once the method is loaded check the sections of the file to see that it is correct for the method you chose.

10. Set the column temperature and pressure limits under the (External Control) section. For ascorbic acid and dehydroascorbic acid the temperature should be set at 22° C, and the pressure limit should be 3000 psi. Select (Gradient). Move to (set up) and pull down the (pump controller) menu. Make changes if necessary and click (okay).
11. On the computer, under the sample queue set the section under FROM to (Acqu) for running samples. Fill the Sample Queue with Sample Name, File Name, etc. To print or retrieve a file from disk put in (Disk). Vial should be set in sequence 1, 2, 3, etc., as they are loaded into the autosampler tray.
12. It may be necessary to prime the pumps with solvent before starting the flow rate. To do this, loosen the prime valve and use the prime syringe to draw 5 ml of solvent through the pumps. Close the prime valve. It may be also helpful to pump some solvent through the pumps but not through the column. Open the pressure release valve and pump solvent at 5 ml/min. Never put this high of a flow through the column. Set flow back to 1 ml/min and then close pressure release valve. Set the %A and %B solvent to the percentages for the start of the isocratic run (for this study 100% A, 0% B).
13. Allow column to equilibrate for approximately 15 minutes or until the pressure stabilizes. Once the column has reach the correct temperature (22°C) and the pressure has stabilized load the sample tray with samples.
14. Prepare sample tray by pipetting samples into glass inserts inserted into vials with a spring and Teflon cap.
15. On the computer select (RUN), execute methods, press start, and click (Okay) to begin background acquisition.
16. Let samples run through sampler. Screen should say "waiting for acquisition to start," the controller should beep, and then read (inject wait), when the sample is injected the controller will read (an injection occurred). The computer will read (acquiring), and the controller will then read (running).
17. When the analysis is complete for all samples quit the monitor program by selecting (quit). Go to "execute methods", edit queue wide parameters and select "printer" for output. Also select "re-integrate peak, save peak, and format peak integration." Go back into execute methods and click (run). Printer should start.

18. For analyzing dehydroascorbic acid click (load) and retype the file name of the method: c:max\data5. Change the sample queue and execute methods.

4. Calculating Ascorbic Acid and Dehydroascorbic Acid Content

1. Determine each sample's AA and DHA content by plugging the peak area for either DHA or AA into their respective standard curves. Sample standard curves for AA and DHA can be seen in Figures G1 and G2 respectively.
2. Values derived from the curve will be in ug/g, convert samples into units of mg/100g of pepper.

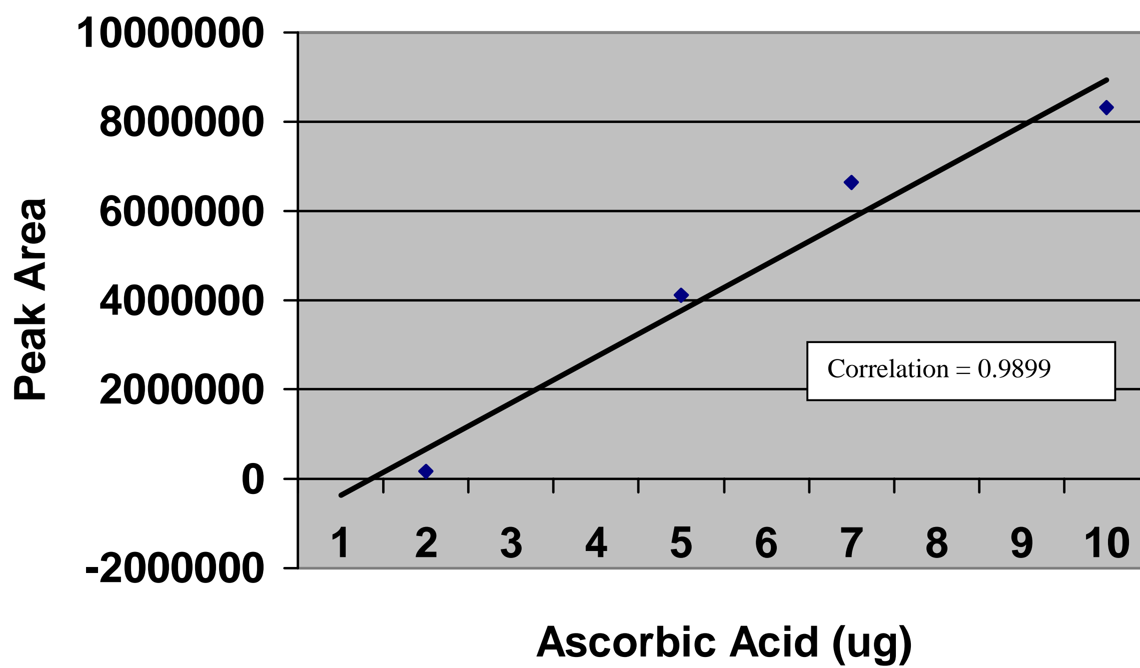

Figure G.1 Ascorbic acid standard curve.

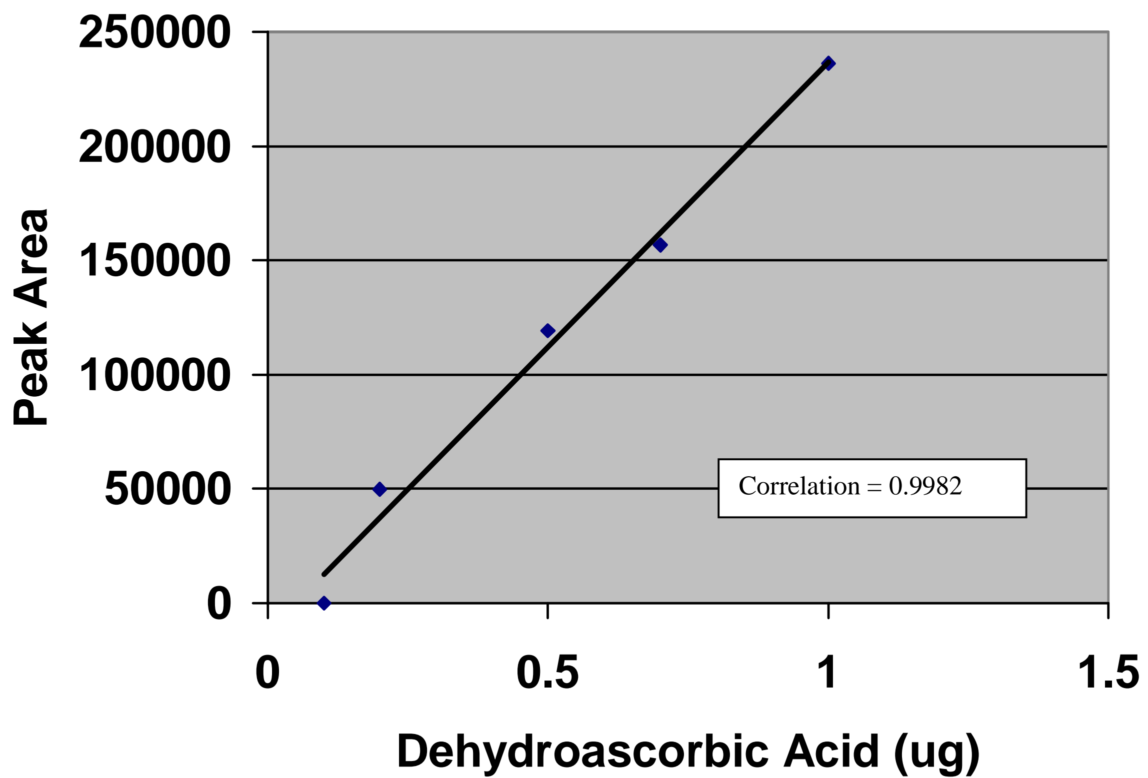

Figure G.2: Dehydroascorbic acid standard curve.

Appendix H - Respiration Analysis

1. Remove 32 peppers (8 from each experimental group) from refrigerated storage 12 hours prior to testing. Allow to come to room temperature in Room 337, Department of Human Nutrition, Foods, and Exercise, Wallace Hall, Virginia Tech, Blacksburg, VA.
2. Transfer samples to the Horticulture Department laboratory, Room 307A, Saunders Hall, Virginia Tech, Blacksburg, VA.
3. Turn on Infrared gas analyzer equipment: Plug in power supply, turn on external air source.
4. Adjust airflow for 5 liter/minute using the attached gauges.
5. Record weight for all samples (to be used in respiration calculation).
6. Place samples, two pepper fruits at a time, in the metal container. Seal container with plastic lid.
7. Adjust the tubing so the analyzer is reading the external air source. Record the external air carbon dioxide value (ppm) after the level has stopped fluctuating.
8. Switch the tubing from the external air source to the source running from the metal container holding the pepper.
9. Wait for the reading to stabilize and then record the carbon dioxide output of the fruit.
10. Repeat steps 1-9 for all samples.
11. Calculate the respiration rate:

Respiration Rate = $(\Delta CO2 \cdot F \cdot K)/A$

Where:

$\Delta CO2$ = CO2 output - CO2 input (ambient air)

F = air flow in liters/hour

K = [44,000 mg carbon dioxide/22.4 L/mol] X (273/294)

(Conversion of 1 L CO2 to 1 mg CO2)

A = kilogram weight of the fruit

Appendix I-"Xanthan Gum" Coating Formulation

28% Humkote (AC Humko, Memphis, TN)

10% Super G (AC Humko, Memphis, TN)

1.2% Alginate (TIC Gums, Belcamp, MD)

0.6% Xanthan Gum (TIC Gums, Belcamp, MD)

60.2 % Distilled Water

1. Melt Humkote and Super G 10 over medium heat, after melted add to blender.
2. Blend melted Humkote and Super G 10 on "blend" setting, while blending adding algin and xanthan gum, continue blending.
3. Add water to blender to form emulsion.
4. Apply coating immediately to fruits surface, allow coating to dry to a haze, and then buff the coating to a shine.

Appendix J-"Locust Bean Gum" Coating Formulation

20% Humkote (AC Humko, Memphis, TN)

18% Super G 10 (AC Humko, Memphis, TN)

1% Locust Bean Gum (TIC Gums, Belcamp, MD)

1% Xanthan Gum (TIC Gums, Belcamp, MD)

60% Distilled Water

1. Melt Humkote and Super G 10 over medium heat, after melted add to blender.
2. Blend melted Humkote and Super G 10 on "blend" setting, while blending adding locust bean gum and and xanthan gum, continue blending.
3. Add water to blender to form emulsion.
4. Apply coating immediately to fruits surface, allow coating to dry to a haze, and then buff the coating to a shine.

Appendix K-"Acid Modified Starch" Coating Formulation

3.5% Humkote (AC Humko, Memphis, TN)

3.5% Super G 10 (AC Humko, Memphis, TN)

15% Pure Coat (Pcoat B790, Modified Food Starch) (Grain Processing Corporation, Muscatine, IL)

5% Glycerol (Vitusa, Berkely Hieghts, NJ)

73% Distilled Water

1. Combine all ingredients and heat over medium heat until melted.
2. Continue heating until the mixture reaches a solids content of 53±2%.
3. Apply coating to fruit surface and allow to air dry, or aid drying with the use of a fan.

Appendix L- "Maltodextrin" Coating Formulation

5.8% Humkote (AC Humko, Memphis, TN)

5.8% Super G 10 (AC Humko, Memphis, TN)

11.6% Star Dri Maltodextrin DE 18 (Staley, Decatur, IL)

40.7% Distilled Water

0.69% Algin (TIC Gums, Belcamp, MD)

0.34% Xanthan Gum (TIC Gums, Belcamp, MD)

34.9% Distilled Water

1. Blend first four ingredients over medium heat until melted.
2. Transfer melted mixture into a blender, set on "blend" setting (moderately high agitation).
3. Add algin and xanthan gum to blender.
4. Add remaining water to the mixture in the blender, continue blending until all water is incorporated.
5. Refrigerate coating for 24 hours prior to use.
6. Apply coating to fruit surface and allow to air dry, or aid drying with the use of a fan.

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Vita

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