2023

Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

Heidy Lizardo
hel3036@rit.edu

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Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

By

Heidy Lizardo

A Thesis Submitted in Fulfillment of the Requirements for the Degree of

Master of Science

in

Packaging Science

College of Applied Science and Technology

Department of Packaging Science

Rochester Institute of Technology

Rochester, New York

2023

Committee Approval:

Carlos Diaz-Acosta, PhD Date

Committee Member

Changfeng Ge, PhD Date

Committee Member

Alexis Rich, M. E. Date

Committee Member

Acknowledgments

This work would not have been possible without the guidance and patience of Dr. Georgios Koutsimanis, professor and mentor.

As important as the research committee members; Alexis, Carlos and Chanfeng.

Thank you.

Abstract

Because of the increased demand for fresh greens presented in an accessible format, the demand for a new packaging technology to extend shelf life has also increased. *Micro perforation* is a packaging system that allows rapidly modifying headspace gases under refrigerated storage. Previous research has demonstrated that the pattern in which the perforations are aligned in the film affects the gas exchange modification of the package headspace gases. A rapid modification of the headspace gases of the product in the package must be achieved in order to guarantee extended shelf life. Several patterns of micro-perforation location and density have been investigated utilizing films made of oriented polypropylene (OPP) and oriented polypropylene laminated with low-density polyethylene (OPP/LDPE).

Headspace composition and physicochemical analysis were evaluated for Spring Mix packed in 6 different pouches, each with a different pattern of its micro-perforation. The samples will be tested until its determined that their integrity has been compromised. The samples remained stored at five °C. After analyzing the data, it was determined that pattern #6 and control showed the best shelf life qualities of the product, which is why it will be furthermore studied with spinach.

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2. Introduction

Fresh greens have long been recognized as an essential component of a healthy diet, providing vital nutrients such as vitamins and minerals necessary for overall well-being (Young, 2015). With an increased awareness of the link between fresh greens consumption and health benefits, more people are adopting the habit of including fresh greens in their meals. Besides their nutritional value, fresh greens are also known for their appealing flavor and visual appeal. They are available in ready-to-eat formats, aligning with the growing trend of convenience and time-saving in food preparation (Jeddi, 2014).

In the context of fresh greens, the shelf life can be defined as the duration during which the product maintains its appealing appearance to consumers (Zhou et al., 2004). However, fresh greens, particularly minimally processed ones, have a limited shelf life. These products are highly perishable due to their increased moisture content, delicate nature, and respiratory activity, which indicates the rate at which the product may deteriorate (Ahvenainen, 1996). To address this challenge, modified atmosphere packaging (M.A.P.) technology has been introduced, aiming to reduce the respiration rate of fresh produce and inhibit fungal growth (Allende et al., 2004).

M.A.P. for minimally processed fresh greens involves adjusting the atmosphere inside the package by manipulating the gases present. This is achieved through the rapid exchange of gases between the product's natural respiration and the gas transfer through the packaging material. The desired outcome is an atmosphere with a higher concentration of carbon dioxide (CO_2) and a lower concentration of oxygen (O_2), which can potentially reduce the respiration rate, decay, and physiological changes of the product (Koutsimanis & Ge, 2017).

However, certain fresh salad mixtures, such as those containing baby spinach and various types of produce like baby lettuces, baby greens, and radicchio, require higher levels of oxygen due to their elevated respiration rate (Babic & Watada, 1996). If the packaging system fails to provide an adequate amount of oxygen, the product may undergo anaerobic respiration, leading to undesirable effects such as browning, the formation of fermentative metabolites, and off-odors, ultimately resulting in the deterioration of the product (Koutsimanis & Ge, 2017).

In cases where elevated levels of carbon dioxide cannot be used, and oxygen-rich packages are necessary, the composition of the headspace gas can be controlled using microperforated films made of various polymeric materials, including commonly used plastics like biaxially oriented polypropylene (BOPP), biaxially-oriented polyethylene terephthalate (BOPET), and low-density polyethylene (Winotapun et al., 2015). Additionally, the microbial population in these packages can be managed through refrigerated storage at temperatures below 4°C (40°F) (Ragaert, Devlieghere & Debevere, 2007).

By implementing M.A.P. and utilizing appropriate packaging materials, the shelf life of minimally processed fresh greens can be extended, allowing for increased marketability and reduced product waste. These advancements in packaging technology enable the preservation of the product's quality and appearance, satisfying consumer preferences for fresh and visually appealing greens.

2.1 Background

In today's food culture, there is a growing demand for minimally processed fresh greens that are convenient to use and consume, while also being recognized as a healthy dietary choice. However, the perishable nature of these products limits their marketability and shelf life to just seven days when stored at a temperature of seven °C (Tuleda et al., 2013). To address this challenge, the use of microperforated film packages has emerged as a solution. By creating the appropriate atmospheric conditions inside the package, the shelf life of minimally processed fresh greens can be extended. This research study aims to conduct a comparative analysis of different microperforated film patterns, providing valuable insights for selecting the most effective pattern that allows for an extended shelf life.

2.2 Review of Past Studies

Modified atmosphere packaging (M.A.P.) typically involves low oxygen (O2) and high carbon dioxide (CO2) compositions. However, previous studies have indicated that minimally processed fresh greens require higher levels of oxygen to maintain their quality due to their high respiration rate (Kader, 2002). In the study conducted by Koutsimanis and Ge (2017) titled "Novel, Micro-Perforated Packaging System for Fresh Salads," the impact of microperforated films on the shelf life and quality maintenance of minimally processed fresh greens was evaluated. Four different film patterns were assessed: continuous film, standard micro-perforation pattern, modified micro-perforation pattern #1, and modified micro-perforation pattern #2. The study demonstrated that the microperforated packaging systems maintained an oxygen-rich atmosphere in the headspace of the packages throughout a 20-day storage period. In contrast, the control bags made of continuous films were unable to provide adequate gas exchange, resulting in anaerobic respiration and product senescence after a shorter storage period. The study emphasized the critical importance of the location and density of micro-perforations in preventing package fogging, moisture condensation, microbial growth, and salad wilting. These factors significantly impact marketability, shelf life, and food waste (Koutsimanis & Ge, 2017). Therefore, a more detailed comparison of each micro-perforation pattern is necessary to determine which pattern allows for an extended shelf life.

2.3 Significance of the Study

The demand for minimally processed fresh greens is increasing in the food market due to the combination of convenience and nutrition they offer, providing consumers with a wider range of options. However, due to their minimal processing and large surface area, these products are susceptible to quality changes that can lead to pathogenic microorganism contamination. Since these greens are consumed raw, it is crucial to prevent desiccation, enzymatic reactions, oxidation, loss of cellular integrity, loss of antioxidants, and microbial deterioration. These quality challenges are directly related to the product's respiration rate, with higher respiration rates indicating a more active metabolism, faster deterioration, and a more rapid loss of flavor quality and nutritional value.

This study offers a comprehensive comparison of different microperforated film patterns and their impact on the shelf life of minimally processed fresh greens. The research enhances our understanding of the shelf life of fresh greens, the nature of their deterioration mechanisms, and the development of microperforated film usage for extending shelf life while maintaining product quality over time. The findings of this study will not only benefit packaging manufacturers in producing high-value-added films for minimally processed fresh greens but also contribute to reducing food waste.

2.4 Purpose Statement

The purpose of this study is to compare different microperforation patterns in flexible packaging systems made of oriented polypropylene and oriented polypropylene/low-density polyethylene. The objective is to determine which microperforation pattern facilitates better headspace gas exchange, resulting in an extended shelf life for minimally processed fresh greens.

3. Theoretical Perspective

The central theory being tested in this study is based M.AP. systems and microperforated film technology to determine how the position of the microperforations on flexible films affects the overall quality of the product in order to determine which pattern allows a better modification of headspace gases in the package delaying senesce of the product. The theoretical perspective will help the researched to emphasize and understand the research problem more clearly as mentioned by Creswell (2014).

Four different types of pouches, made of: i) oriented polypropylene (OPP) and ii) oriented polypropylene laminated with low density polyethylene (OPP/LDPE), have been tested for shelf life extension of minimally processed fresh greens. Using continuous film, standard microperforation pattern with 2 vertical lines of microperforations per side, modified microperforation pattern with 4 lines of horizontal microperforations per side, and modified microperforation pattern with 4 lines of horizontal microperforations on the upper part of the front side and the lower part of the rear side of the pouch. Each of the microperforated pouch with 96 microperforations totals per pouch surface area with average microperforation size of 110 μm.

4. Hypotheses

This study will investigate the effects of micro-perforation patterns in films and their influence on minimally processed fresh greens' qualities and shelf life, such as spring mix and spinach. The assumption is that the perforation’s location may influence the overall properties and shelf life of the products.

H1: Variable 2 micro-perforation pattern stored at 40 °F increases Spring Mix shelf life.

H2: Variable 5 micro-perforation pattern stored at 40 °F increases Spring Mix shelf life.

H3: Variable 6 micro-perforation pattern stored at 40 °F increases Spring Mix shelf life.

H4: There is no significant difference between micro-perforation pattern stored at 40 °F and traditional film.

5 Literature Review

The literature review in this research study serves several purposes. Firstly, it aims to provide a comprehensive overview of related past studies that support and inform the information and concepts discussed in the proposed research. This review helps establish the scope of the study and provides a benchmark for comparing and interpreting the research findings. Additionally, the literature review helps refine and validate the research questions, highlighting the significance and importance of the study, as emphasized by Creswell (2014). In this research, the literature review is conducted from a post-positivist worldview, encompassing various topics relevant to the study.

5.1 Modified Atmosphere

Packaging Modified Atmosphere Packaging (M.A.P.) is a principle in which the air inside a product's packaging is replaced with a specific mixture of gases or controlled to maintain desired gas concentrations. This technology has been developed to prolong the freshness and visual appeal of packaged food products. The essence of modified atmosphere packaging lies in modifying the packaging atmosphere to significantly reduce spoilage and extend the product's shelf life (Ooraikul, 1991). In this research study, the focus is on exploring M.A.P. from the perspective of micro-perforation technology.

5.1.2 Micro-perforation

Micro-perforation is a technique used in designing packaging for fresh or minimally processed fruits and vegetables. This technology has enabled the extension of shelf life for fresh-cut salads in a cost-effective and efficient manner.

Since Modified Atmosphere Packaging may not always provide the required oxygen levels for fresh-cut produce and may also need to meet other packaging requirements such as puncture resistance and freezer capability, incorporating micro-perforations becomes necessary to meet the gas exchange requirements (Abdellatief et al., 2015).

5.2 Minimally Processed Fresh Greens

Minimally processed fresh greens refer to products that have undergone sorting, cleaning, washing, trimming/peeling/coring, and cutting processes. These products are typically prewashed and packed in bags or containers without undergoing thermal treatments (Brody, A. L., Zhuang, H., and Han, J. H., 2010). For the purpose of this study, the specific products under investigation are prepacked Spring Mix salad and Spinach.

6. Methodology

6.1 Research design

In quantitative research, the aim is to determine the relationship and correlation between variables in hypotheses to verify the study's outcome, as recommended by Creswell (2014). This study intends to investigate the effects of the micro-perforation pattern in packaging film and its effects on the quality and shelf life of minimally processed fresh greens. After storing the minimally processed fresh greens in films with different perforation patterns, the pattern's effect on the product may be noticeable, as suggested by Koutsimanis and Ge (2016).

6.2 Strategy of inquiry

The comprehensive research approach plan for the development of this experimental research consists of a post-positivism philosophical worldview, which keynotes are

- knowledge is conjectural,
- research is a process of making claims and then refining or abandoning some of them for other claims more strongly warranted, and
- knowledge is shaped by data, evidence, and rational consideration.

An accurate experimental study will be used as the strategy of inquiry. In the experiment, a researcher will select samples by random sampling to ensure validity and reduce any biased study results (Creswell, 2014). This strategy will be implemented in most parts of the research study, such as the plastic film and fresh greens quality testing.

6.3 Materials

6.3.1 Materials

1) Oriented polypropylene (OPP) and oriented polypropylene laminated with low density polyethylene (OPP/LDPE) microperforated film

2) Spring mix salad

6.4 Experimental procedures

Refrigerated, triple-washed salad mix (baby lettuces, red and green chard, mizuna, arugula, radicchio, and baby spinach) shipped overnight from Salinas, CA, to Rochester, NY, utilizing ice packs in a corrugated case in order to ensure uninterrupted refrigeration. The spring mix was stored at three °C and 75% R.H. for 24 hours upon arrival. The next day, careful sorting by hand removed any damaged leaves before packaging.

6.4.1 Headspace analysis

Oxygen, CO2, and Nitrogen in the headspace of each bag will be measured using a Model 6600 O2/CO2/N Headspace Analyzer. Results are expressed as % of gas.

6.4.2 Weight loss analysis

Weight changes were monitored using an Explorer Pro precision balance (Ohaus Corp, Parsippany, NJ, USA). Results were expressed as % weight loss.

6.4.3 pH analysis

A model 563W2 Ph-meter will be utilized to determine the pH of the sample.

6.4.4 Titratable acidity

With a standard 100 mL pipette, Sodium Hydroxide will be poured into a 10:100 diluted sample, which will contain an electrode. Once the Ph-meter marks 8.0, the pouring will stop, and the amount of NaOH will be determined by looking at the pipette marks. After this has been determined, a formula, as shown in formula 6.5.4, will be done to determine the °Dornic of the sample.

Formula 6.5.4 Titratable acidicity

$$\% \text{ acid} = \frac{(\text{mls of NaOH used}) * (0.1 \text{ N NaOH}) * (\text{milliequivalent factor}) * 100}{\text{Grams of sample}}$$

6.4.5 Solid solubles

Solid soluble were measured with a model 1000W-2 refractometer. The equipment will be calibrated each time before testing another sample. Finally, the sample will be poured into the lens, and a measurement will be taken.

6.4.6 Antioxidants analysis

Extraction and quantification of chlorophylls and carotenoids will be done by collecting 0.3 grams of tissue and combining 10 mL of pure methanol. Samples were incubated in the dark for 24 hours at room temperature. After this period, absorbance at the control, variable 2, and variable 6 nm was measured for carotenoids, chlorophyll b, and chlorophyll a, respectively.

6.5 Limitations

Due to this research focusing on studying shelf life extension only of spring mix and spinach with the use of microperforated packaging film, it means that if other types of fresh greens are evaluated with this technology, the expected maximum shelf life may not be the same because of its respiration rate difference.

6.6 Bag patterns

Three types of pouches were utilized utilizing: a) continuous film with perforations on the top front and bottom back (control), b) continuous film with perforations on the top back and bottom front (V6), and c) standard microperforation pattern with 2 vertical lines of microperforations per side, one set un the top front and the other on the bottom back.

Each of the microperforated pouches (22 x 30 cm) had a total of 96 microperforations per pouch surface area. Continuous and laser-microperforated films with average microperforation size of 110 µm, made of: i) oriented polypropylene (OPP) and ii) oriented polypropylene laminated with low density polyethylene (OPP/LDPE) were supplied by American Packaging Corp. (APC, Rochester, NY, USA). The results discussed below represent the sum of collected data from bags made of OPP and OPP/LDPE since no significant differences were observed between the packaging systems.

Figure 1

Microperforated bag pattern control

Note. Continuous film with perforations on the top front and bottom back with average microperforation size of 110 µm

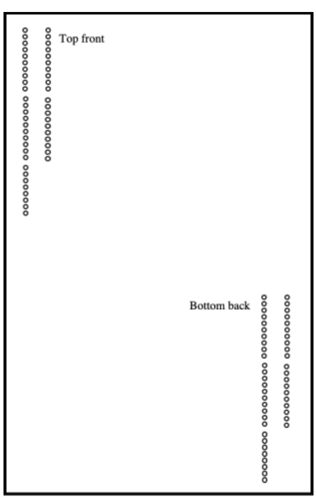
Figure 2

Microperforated bag pattern V6

Note. Continuous film with perforations on the top back and bottom front (V6), with average microperforation size of 110 µm

Figure 3

Microperforated bag pattern V6



Note. Standard microperforation pattern with 2 vertical lines of microperforations per side, one set un the top front and the other on the bottom back (V2).

6.7 Level of acceptance

Acceptance Level means the Parameters and rejection limits set out in the Specifications. The level of acceptance for this study is 0.5.

7. Data Analysis

This study relies on an experimental research approach, which involves collecting quantitative data and analyzing it using descriptive statistics to measure the variables related to the hypotheses, as recommended by Creswell (2014). Descriptive statistics provide a summary of the data, including measures such as mean, median, and standard deviation. These measures help in understanding the central tendency and variability of the data, allowing for a comprehensive analysis of the results.

Standard deviation, a commonly used measure of variability, will be calculated and provided in the descriptive analysis. This measure indicates the extent to which data points deviate from the mean. By including the standard deviation in the analysis, it becomes possible to assess the dispersion of the data and evaluate the consistency or variability of the results.

To determine the significant differences between the means of each sample compared to a control variable, a one-way ANOVA (analysis of variance) and t-test will be employed. These statistical tests are used to compare means across different groups and determine if there are statistically significant differences between them. The one-way ANOVA is suitable for comparing means among three or more groups, while the t-test is used for comparing means between two groups.

According to Creswell (2014), the analyzed results will be crucial in supporting or rejecting the hypotheses in this quantitative research study. By examining the statistical significance of the data, researchers can draw meaningful conclusions and make informed decisions regarding the research questions and hypotheses.

In addition to the one-way ANOVA and t-test, Tukey's test will be used to determine which samples are significantly different from each other. This post-hoc test is commonly employed after an ANOVA to identify specific group differences when there are three or more groups. Tukey's test allows for pairwise comparisons of group means, enabling researchers to determine which groups differ significantly and which do not.

Overall, by utilizing these statistical methods, this study aims to provide a comprehensive and rigorous analysis of the quantitative data collected. The use of descriptive statistics, one-way ANOVA, t-test, and Tukey's test will help in examining the relationships between variables, identifying significant differences, and drawing meaningful conclusions from the experimental research data.

8. Results and Discussion

8.1 Antioxidants

The provided data presents the results of tests conducted on three different types of microperforated film (control, variable 2, and variable 6) used for packaging spring mix. The tests were conducted at various time points, specifically on day 5, 10, 11, 12, 13, 14, 15, 16, and 17. The measurements recorded include the levels of antioxidants present in the spring mix when stored in bags made from each type of microperforated film.

Antioxidants play a crucial role in preventing the oxidation of food products, thereby extending their shelf life and maintaining their nutritional value. In this study, the effectiveness of the microperforated films in preserving the antioxidant content of the spring mix was assessed.

Analyzing the results, it is observed that the antioxidant levels vary across the different types of microperforated film and time points. At day 5, all three types of film (control, variable 2, and variable 6) demonstrated varying degrees of effectiveness in preserving the antioxidants. The control exhibited the highest levels of antioxidants among the three, followed by bag variable 6 and variable 2. This suggests that the microperforated film with a code of the control is potentially more effective in maintaining the antioxidant content of the spring mix during the initial storage period.

As the testing progressed to day 10, the same trend in the effectiveness of the microperforated films was observed. The control consistently showed higher antioxidant levels compared to the other two types of film, indicating its superior performance in preserving the antioxidants in the spring mix.

On day 11, a shift in the results was observed. The control, which previously demonstrated higher antioxidant levels, now showed lower levels compared to variable 2 and bag variable 6. This shift could be attributed to several factors such as variations in film permeability, interaction between the film and the spring mix, or changes in the storage conditions.

Continuing to day 12, control still exhibited the lowest antioxidant levels among the three types of film. Variable 2consistently showed higher levels compared to bag variable 6, suggesting that variable 2 may provide better preservation of antioxidants in the spring mix.

At day 13, the control continued to show lower antioxidant levels compared to variable 2 and variable 6. Variable 2consistently demonstrated higher antioxidant levels, indicating its potential effectiveness in preserving the antioxidant content of the spring mix.

The trend continued on day 14, with variable 2 consistently outperforming the control in terms of antioxidant preservation. Bag variable 6 also showed comparable results to variable 2, suggesting its effectiveness in preserving antioxidants.

On day 15, the antioxidant levels in variable 2 remained relatively stable and higher compared to the other two types of film. Bag control consistently exhibited the lowest levels of antioxidants.

Based on the available data, it can be inferred that bag variable 2 consistently demonstrated better preservation of antioxidants in the spring mix compared to bags control and variable 6. However, further analysis and experimentation would be necessary to draw definitive conclusions and identify the underlying factors influencing these results.

It is worth noting that factors other than the microperforated film itself, such as storage conditions, initial antioxidant content of the spring mix, and interactions between the film and the food product, can also affect the observed results. These factors should be considered when interpreting the data and making decisions regarding the packaging of spring mix to preserve its antioxidant content effectively.

8.2 Damaged leaves

In this discussion, we will analyze the data regarding damaged leaves on spring mix and the effectiveness of three different types of microperforated films (control, variable 2, variable 5) over a period of several days. The data includes measurements taken on days 5, 10, 11, 12, 13, 14, 15, 16, and 17. Let's examine the results obtained from the study:

Table 1

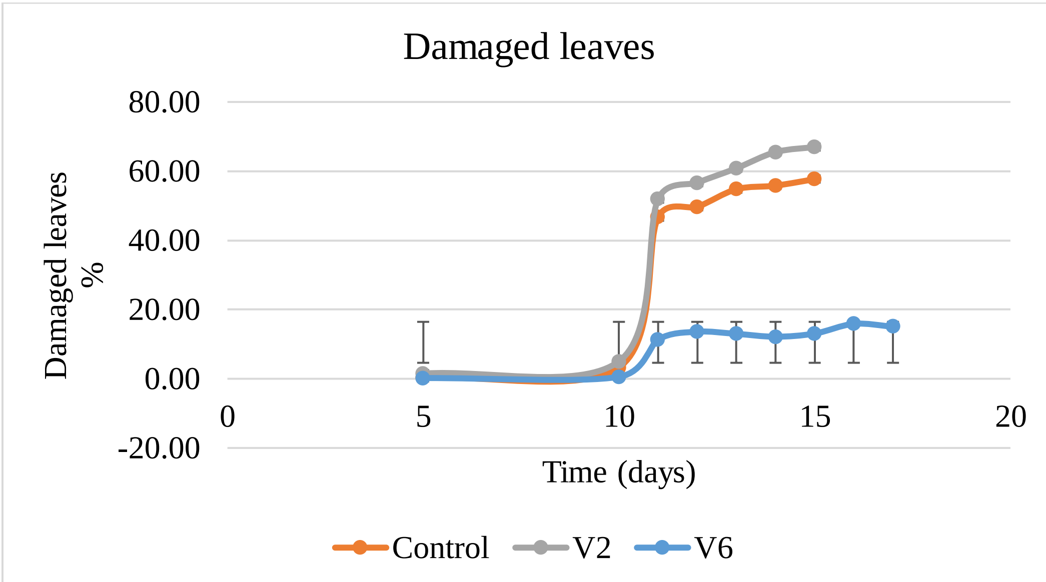
Analysis for damaged leaves

Test Day	Control	V2	V6
5	0.24	1.51	0.19
10	3.29	5.04	0.56
11	46.67	51.89	11.33
12	49.68	56.65	13.59
13	54.77	60.85	12.98
14	55.82	65.52	12.15
15	57.70	66.95	13.06
16	Not tested	Not tested	15.87
17	Not tested	Not tested	15.06

Lizardo, H (2018). Analysis for damaged leaves. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

Graph 1

Analysis for damaged leaves



Lizardo, H (2018). Analysis for damaged leaves. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

The results indicate the level of damage observed on the spring mix leaves under different conditions represented by the control and three types of microperforated films (V2, V5, and V6) on various test days.

Initially, on day 5, the control group exhibited a minimal damage level of 0.24. In comparison, all three microperforated films (V2, V5, and V6) demonstrated higher levels of damage, with V2 showing the highest at 1.51. This suggests that the microperforated films may have contributed to an increased level of leaf damage compared to the control group.

As the test progressed to day 10, the control group's damage level increased to 3.29, while V2 experienced a higher level of damage at 5.04. Conversely, V5 and V6 showed significantly lower damage levels, with V5 recording only 0.10 and V6 measuring 0.56. It appears that V5 and V6 were more effective at preventing leaf damage compared to V2 and the control group.

On day 11, all groups experienced a significant increase in leaf damage. The control group reached 46.67, while V2, V5, and V6 recorded damage levels of 51.89, 26.34, and 11.33, respectively. V6 demonstrated the lowest damage level among the three microperforated films on this day, indicating its effectiveness in reducing leaf damage.

The trend continued on day 12, with increasing damage levels across all groups. The control group had a damage level of 49.68, while V2, V5, and V6 measured 56.65, 27.63, and 13.59, respectively. Once again, V6 showcased the lowest damage level among the microperforated films.

Days 13 and 14 showed a consistent pattern with higher damage levels for all groups. However, V6 continued to outperform the other films in terms of mitigating leaf damage.

On day 15, the control group reached a damage level of 57.70, while V2, V5, and V6 recorded 66.95, 31.10, and 13.06, respectively. V6 maintained its effectiveness in minimizing leaf damage.

The data for the damaged leaves and the effects of the microperforated films for days 16 and 17 are not available for the control group and V2 is not available due to the variables being too damaged, it means that the specific measurements and observations necessary to assess the condition of the leaves and the impact of the films were not feasible or were compromised.

Without the data, it is challenging to discuss the extent of leaf damage or draw conclusions about the effectiveness of the different microperforated films in mitigating damage to the spring mix. It would be necessary to conduct further studies or experiments with proper data collection protocols to investigate the relationship between the films and leaf damage more effectively.

However, V5 and V6 recorded damage levels of 32.60 and 15.87 on day 16, and 31.72 and 15.06 on day 17, respectively.

Overall, the results suggest that V6, represented by microperforated film variable 6, consistently exhibited the lowest levels of leaf damage among the three films tested. It appears to be more effective in protecting the spring mix leaves compared to the control group and the other microperforated films (V2 and V5). However, it is important to note that further analysis and experimentation would be necessary to draw definitive conclusions and understand the underlying factors contributing to these results.

Factors such as the permeability of the microperforated films, interactions between the films and the spring mix, and variations in storage conditions could potentially impact the observed levels of leaf damage. Therefore, careful consideration of these factors is crucial when interpreting the data and making decisions regarding the packaging of spring mix to minimize leaf damage effectively.

8.3 Titratable acidity

In this discussion, we will examine the data pertaining to the titratable acidity of spring mix and its interaction with three different types of microperforated films (control, variable 2, and variable 6). The measurements were taken on various test days, including day 5, 10, 11, 12, 13, 14, 15, 16, and 17. The results obtained from the study are as follows:

Table 2

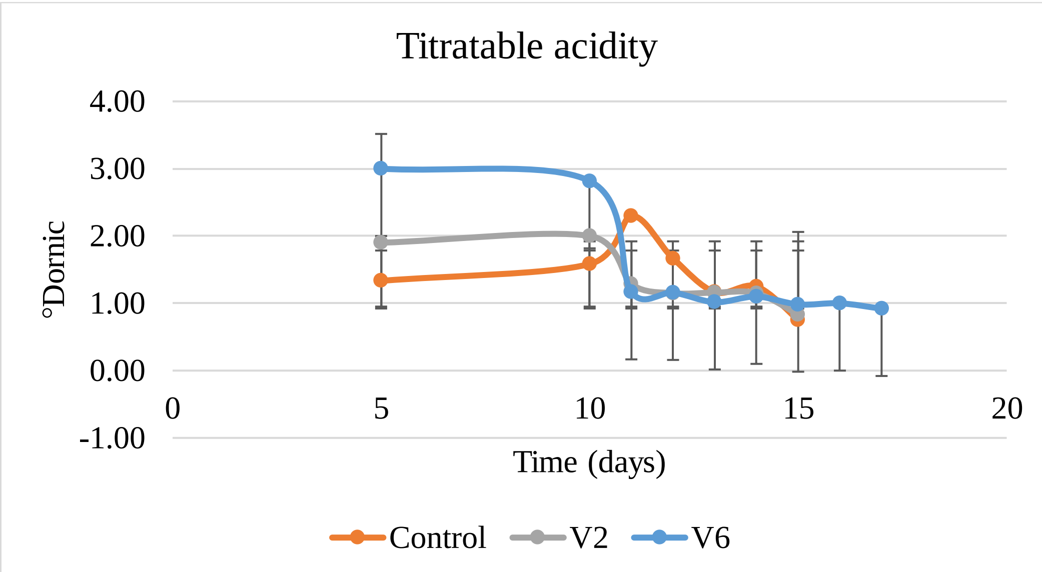
Analysis for titratable acidity

Test Day	Control	V2	V6
5	1.33	1.90	3.00
10	1.58	2.00	2.82
11	2.30	1.28	1.17
12	1.67	1.15	1.16
13	1.17	1.16	1.02
14	1.25	1.15	1.10
15	0.75	0.83	0.98
16	Not tested	Not tested	1.00
17	Not tested	Not tested	0.92

Lizardo, H (2018). Analysis for Titratable acidity. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

Graph 2

Analysis for titratable acidity



Lizardo, H (2018). Analysis for Titratable acidity. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

The results indicate the levels of titratable acidity observed in the spring mix under different conditions represented by the control and three types of microperforated films (V2, V5, and V6) on various test days.

Initially, on day 5, the control group exhibited a titratable acidity level of 1.33. Among the microperforated films, V6 recorded the highest acidity level at 3.00, followed by V5 at 2.83, and V2 at 1.90. This suggests that the use of microperforated films may have influenced the titratable acidity of the spring mix, with V6 resulting in the highest acidity.

On day 10, all groups showed an increase in titratable acidity compared to day 5. The control group had a value of 1.58, while V2, V5, and V6 measured 2.00, 2.87, and 2.82, respectively. V5 demonstrated the highest acidity level among the microperforated films, indicating its potential impact on the titratable acidity of the spring mix.

However, on day 11, a notable shift occurred, with the control group exhibiting a higher acidity level of 2.30 compared to the microperforated films. V2, V5, and V6 recorded acidity levels of 1.28, 1.08, and 1.17, respectively. This suggests that the use of certain microperforated films may have resulted in a decrease in the titratable acidity of the spring mix compared to the control group.

Days 12 and 13 showed similar trends, with the control group maintaining higher acidity levels compared to the microperforated films. On day 12, the control group had an acidity level of 1.67, while V2, V5, and V6 measured 1.15, 1.17, and 1.16, respectively. Day 13 recorded acidity levels of 1.17 for the control group, 1.16 for V2, 1.03 for V5, and 1.02 for V6.

On day 14, an interesting observation was made, with V5 exhibiting a significantly lower acidity level of 0.50 compared to the other groups. The control group had a titratable acidity of 1.25, V2 measured 1.15, and V6 recorded 1.10. This suggests that V5, among the microperforated films, may have influenced the acidity levels differently.

Day 15 showed a consistent decrease in titratable acidity across all groups. The control group had an acidity level of 0.75, V2 measured 0.83, V5 recorded 0.47, and V6 had 0.98. V5 demonstrated the lowest acidity level among the microperforated films on this day.

Unfortunately, data for days 16 and 17 are not available for the control group and V2. the variables were too damaged and further testing was not possible, it means that the measurements and observations necessary to determine the titratable acidity of the spring mix and the effects of the microperforated films were not feasible or compromised.

Titratable acidity is an important parameter in assessing the freshness and quality of perishable foods. It provides an indication of the acidity level and can be used to monitor the progress of biochemical reactions that occur during food spoilage. Without the availability of data on titratable acidity, it becomes challenging to evaluate the impact of the microperforated films on the acidity of the spring mix.

To gain a better understanding of the relationship between the films and titratable acidity, it would be necessary to conduct further studies or experiments with proper data collection protocols. This would involve ensuring the integrity of the variables and implementing appropriate techniques for measuring titratable acidity in the spring mix samples.

However, V5 and V6 recorded acidity levels of 0.72 and 1.00 on day 16, and 0.65 and 0.92 on day 17, respectively.

Overall, the data suggests that the use of microperforated films may have influenced the titratable acidity of the spring mix to some extent. However, the specific impact varies among the different films tested. While some films resulted in higher acidity levels compared to the control group, others exhibited lower acidity levels.

It is important to note that titratable acidity is influenced by various factors, including the composition of the spring mix, packaging conditions, and storage duration. Therefore, further analysis and experimentation would be required to determine the precise effects of microperforated films on the titratable acidity of the spring mix and understand the underlying mechanisms involved.

Understanding the changes in titratable acidity is crucial in assessing the quality and freshness of the spring mix. Future studies could explore additional variables, such as changes in other biochemical parameters or sensory evaluations, to gain a comprehensive understanding of the impact of microperforated films on the overall quality of the product.

8.4 pH

In this discussion, we will analyze the data concerning the pH levels of spring mix under the influence of three different types of microperforated films (control, variable 2, and variable 6). The measurements were taken on various test days, including day 5, 10, 11, 12, 13, 14, 15, 16, and 17. The obtained results are as follows:

Table 3

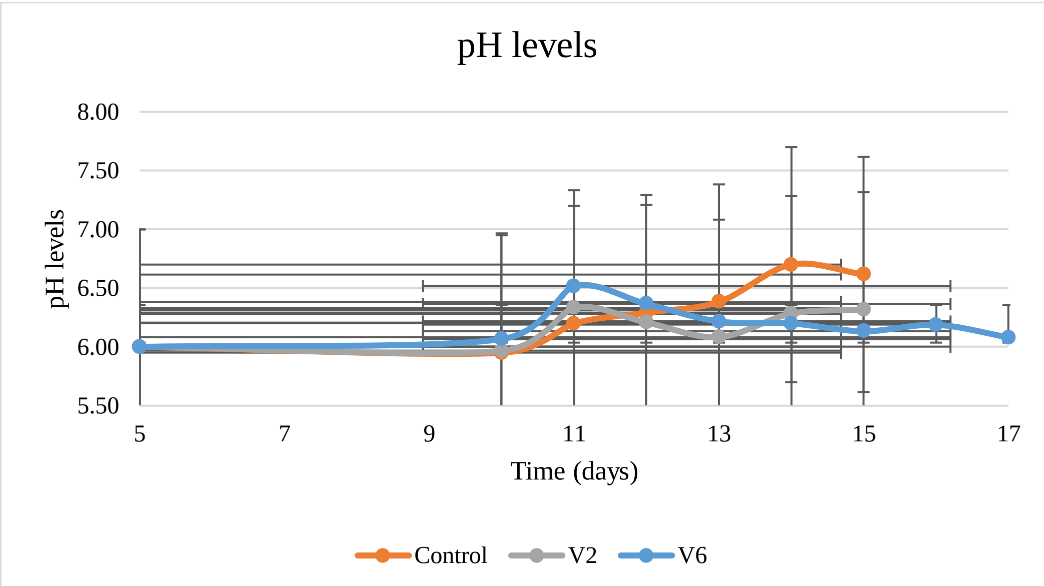
Analysis for pH

Test Day	Control	V2	V6
5	6.00	6.00	6.00
10	5.95	5.97	6.07
11	6.20	6.33	6.52
12	6.29	6.21	6.37
13	6.38	6.08	6.22
14	6.70	6.28	6.20
15	6.62	6.32	6.13
16	Not tested	Not tested	6.19
17	Not tested	Not tested	6.08

Lizardo, H (2018). Analysis for pH acidity. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

Graph 3

Analysis for pH acidity



Lizardo, H (2018). Analysis for Titratable acidity. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

The results provide information on the pH levels observed in the spring mix under different conditions represented by the control and three types of microperforated films (V2, V5, and V6) on various test days.

On day 5, the pH levels were relatively consistent across all groups, with values ranging from 6.00 to 6.12. The control group and V6 exhibited the same pH level of 6.00, while V2 had a pH of 6.00, and V5 measured 6.12. This indicates that the microperforated films had a minimal impact on the pH of the spring mix compared to the control group.

Similar trends were observed on day 10, with the pH levels remaining relatively stable. The control group had a pH of 5.95, while V2, V5, and V6 recorded pH levels of 5.97, 6.08, and

6.07, respectively. These results suggest that the microperforated films had a negligible effect on the pH of the spring mix, as the differences were minimal compared to the control group.

On day 11, a slight variation was observed, with the control group measuring a pH of 6.20. V2 recorded a higher pH level of 6.33, while V5 and V6 had pH levels of 6.07 and 6.52, respectively. These findings indicate that certain microperforated films, such as V6, may have influenced the pH levels of the spring mix differently compared to the control group.

Days 12 and 13 exhibited relatively consistent pH levels across the groups. On day 12, the control group had a pH of 6.29, while V2, V5, and V6 measured 6.21, 6.08, and 6.37, respectively. Day 13 recorded pH levels of 6.38 for the control group, 6.08 for V2, 6.08 for V5, and 6.22 for V6.

An interesting observation was made on day 14, with V5 exhibiting a higher pH level of 6.43 compared to the other groups. The control group had a pH of 6.70, V2 measured 6.28, and V6 recorded 6.20. This suggests that V5, among the microperforated films, may have influenced the pH levels of the spring mix differently.

Day 15 showed relatively consistent pH levels across the groups, ranging from 6.13 to 6.62. The control group had a pH of 6.62, V2 measured 6.32, V5 recorded 6.43, and V6 had 6.13. These results indicate that the microperforated films did not have a significant impact on the pH levels of the spring mix compared to the control group.

Unfortunately, data for days 16 and 17 are not available for the control group and V2. The variables were too damaged and further testing was not possible, it means that the measurements and observations necessary to determine the pH of the spring mix and the effects of the microperforated films were not feasible or compromised.

pH is a critical parameter that indicates the acidity or alkalinity of a solution, and it plays a significant role in determining the freshness and quality of food products. Without the availability of pH data, it becomes challenging to assess the impact of the microperforated films on the pH levels of the spring mix.

To obtain meaningful insights into the relationship between the films and pH, it would be necessary to conduct additional studies or experiments with proper data collection procedures. This would involve ensuring the integrity of the variables and implementing appropriate techniques for measuring the pH of the spring mix samples.

However, V5 and V6 recorded pH levels of 6.29 and 6.08 on day 17, respectively. Overall, the data suggests that the use of microperforated films may have had minimal effects on the pH levels of the spring mix. While some variations were observed among the different films tested, the differences were relatively small compared to the control group. It is important to note that pH levels can be influenced by various factors, including the composition of the spring mix, packaging conditions, and storage duration. Further analysis and experimentation would be required to determine the precise effects of microperforated films on the pH levels of the spring mix and to understand the underlying mechanisms involved.

Understanding the pH levels of the spring mix is crucial in evaluating its quality and freshness. Future studies could explore additional variables, such as changes in other biochemical parameters or sensory evaluations, to gain a comprehensive understanding of the impact of microperforated films on the overall quality of the product.

8.5 Sensory

In this discussion, we will examine the sensory evaluation results of spring mix under the influence of three different types of microperforated films (control, variable 2, and variable 6).

The sensory evaluation included assessments of appearance, color, aroma, texture, and moisture of the spring mix.

The sensory evaluation of the spring mix and microperforated films provides insights into the changes in appearance, color, aroma, texture, and moisture over the testing period.

On day 5, all variables, including the control group and microperforated film variations (V2, V5, and V6), received similar scores in all sensory attributes, maintaining an overall rating of 5.00. This suggests that there were no noticeable differences in sensory characteristics among the samples on this day.

However, on day 10, the control group exhibited a decrease in ratings for all attributes, receiving scores of 4.00. V2 also showed a decline in sensory scores compared to the control group, particularly in appearance, color, aroma, and texture. In contrast, V5 and V6 maintained a rating of 3.00 for most attributes, indicating better sensory performance compared to V2.

On day 11, further decreases in sensory ratings were observed for the control group, particularly in appearance, color, aroma, and texture, where it received scores of 3.00 and 2.00. V2 and V5 exhibited similar declines in scores across various attributes. Notably, V6 performed relatively better in appearance and aroma, but it showed a decline in color and texture ratings as well.

Day 12 recorded a significant decrease in sensory ratings for the control group, dropping to 1.00 for appearance, 2.00 for color and aroma, and 21.00 for moisture. V2, V5, and V6 also experienced declines in sensory scores, although V2 had the highest scores among the microperforated film variations.

On day 13, the control group continued to exhibit a decrease in sensory ratings, reaching 2.00 for appearance and 1.00 for aroma and moisture. V2 experienced the most substantial decline among the microperforated film variations, receiving scores of 1.00 and 0.50 for appearance and aroma, respectively. V5 and V6 maintained scores close to their previous ratings.

The sensory evaluation on day 14 showed a complete loss of sensory characteristics for the control group, receiving scores of 0.00 across all attributes. Similarly, V2 received a score of 0.00, indicating a complete loss of sensory quality. V5 and V6 maintained relatively high scores, suggesting better sensory performance compared to the control group and V2.

Day 15 demonstrated no sensory characteristics for the control group and V2, with scores of 0.00. V5 and V6 retained sensory attributes, maintaining scores of 2.80 across various attributes.

Unfortunately, data for days 16 and 17 are not available for the control group and V2, limiting the analysis of their sensory performance the sensory measurements and observations required to assess the appearance, color, aroma, texture, and moisture of the spring mix, as well as the effects of the microperforated films, were not feasible or compromised.

Sensory evaluation is a valuable tool in assessing the quality and acceptability of food products. It provides valuable insights into the sensory attributes that influence consumer perception and preference. Without available sensory data, it becomes challenging to evaluate the sensory characteristics of the spring mix and draw conclusions about the impact of the microperforated films on its sensory properties.

To obtain meaningful insights into the sensory aspects, it would be necessary to conduct additional studies or experiments with proper data collection procedures. This would involve ensuring the integrity of the variables and implementing appropriate sensory evaluation techniques, such as trained panel evaluations or consumer taste tests, to assess the sensory attributes of the spring mix samples.

However, V5 and V6 consistently maintained scores of 3.00 in appearance, color, aroma, and texture, indicating stable sensory characteristics.

In summary, the sensory evaluation of the spring mix and microperforated films revealed changes in appearance, color, aroma, texture, and moisture over the testing period. The control group exhibited a progressive decline in sensory scores, indicating deteriorating sensory characteristics, while the microperforated film variations, particularly V5 and V6, demonstrated better sensory performance in terms of maintaining overall quality. These findings highlight the potential of microperforated films, such as the control, variable 2, and variable 6. variations, in preserving the sensory attributes of spring mix over time.

8.6 Solid Levels

The analysis of the solids level (°Bx) in the spring mix and the three different types of microperforated films (control, variable 2, and variable 6). provides insights into the changes in sugar content or soluble solids over the course of the testing period. On day 5, the control group exhibited a solids level of 0.45 °Bx, while V2, V5, and V6 showed slightly higher levels at 0.47 °Bx, 0.55 °Bx, and 0.68 °Bx, respectively. These results suggest some variation in sugar content among the different samples.

At day 10, the control group maintained a similar solids level of 0.48 °Bx, indicating a relatively stable sugar content. In contrast, V2 showed an increase to 0.67 °Bx, while V5 and V6 exhibited lower levels at 0.47 °Bx and 0.55 °Bx, respectively.

On day 11, the control group and V6 both displayed an increase in solids level, reaching 0.53 °Bx and 0.87 °Bx, respectively. V2 and V5 had lower levels at 0.40 °Bx and 0.45 °Bx, respectively. These results indicate some variations in sugar content among the samples, with V6 showing the highest level.

Day 12 recorded a decrease in solids level for all samples. The control group had a level of 0.47 °Bx, while V2, V5, and V6 showed lower levels at 0.28 °Bx, 0.38 °Bx, and 0.62 °Bx, respectively.

On day 13, a further decrease in solids level was observed across all samples. The control group had the highest level at 0.40 °Bx, while V2, V5, and V6 exhibited lower levels at 0.17 °Bx, 0.30 °Bx, and 0.37 °Bx, respectively.

Day 14 showed significant variations in solids level among the samples. The control group had a higher level at 0.75 °Bx, while V2, V5, and V6 displayed lower levels at 0.40 °Bx, 0.28 °Bx, and 2.12 °Bx, respectively. The higher level in V6 suggests a potential increase in sugar content or soluble solids.

The solids level continued to increase on day 15, with the control group reaching 0.93 °Bx. V2 and V5 also showed higher levels at 0.98 °Bx and 0.58 °Bx, respectively, while V6 had a significant increase to 1.95 °Bx. Unfortunately, data for days 16 and 17 are not available for the control group and V2, limiting the analysis of their solids level. Since the data for the solids level (°Bx) of the spring mix and the microperforated films is not available for days 16 and 17 for the control group and V2, it is not possible to provide a detailed analysis of the solids level for those specific variables on those days. Without complete data, it is challenging to draw meaningful conclusions about the changes in sugar content or soluble solids for those particular samples.

However, based on the available data, we can still observe trends and patterns in the solids level for the tested samples over the provided time frame. The results show variations in the solids level among the different variables and days. It is important to note that the absence of data for the control group and V2 on days 16 and 17 limits our understanding of the overall trends in sugar content for those specific samples.

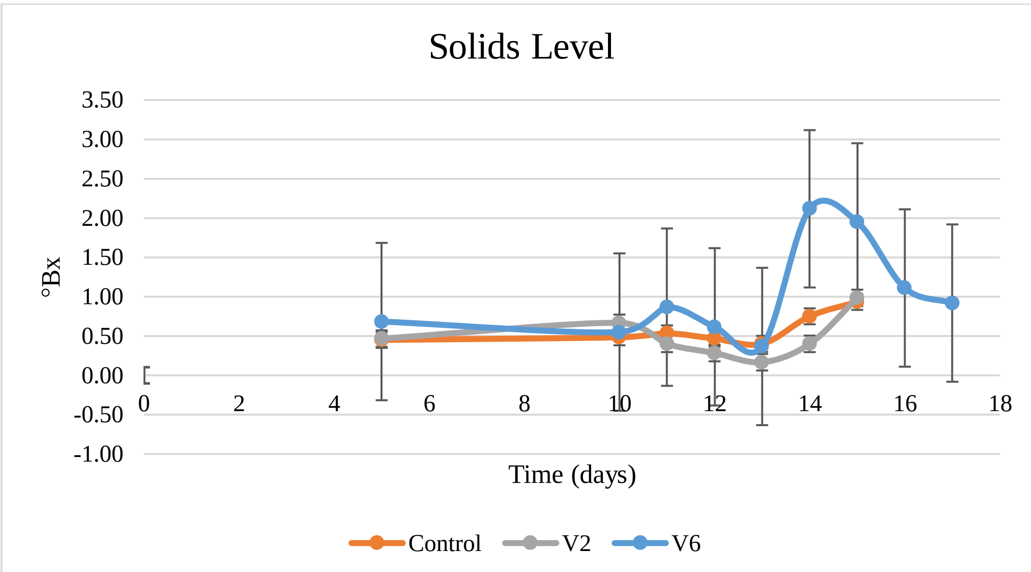
Further research and analysis with complete data would be necessary to gain a comprehensive understanding of the solids level in the spring mix and the effects of the different microperforated films on sugar retention over the entire testing period.

However, V5 and V6 maintained relatively stable levels, with V6 consistently exhibiting higher levels compared to the other samples.

In summary, the analysis of the solids level in the spring mix and the microperforated films revealed variations in sugar content or soluble solids over the testing period. The control group and the different microperforated film variations exhibited fluctuations in their solids level, suggesting changes in the sugar content of the samples. Notably, V6 consistently displayed higher levels of sugar content compared to the other variations, indicating a potential impact of the microperforated film on the sugar retention in the spring mix. These findings emphasize the importance of considering the choice of packaging materials in preserving the quality and sugar content of perishable food products like spring mix.

Graph 4

Analysis for solid levels



Lizardo, H (2018). Analysis for solid levels. In the Analysis of Micro-Perforated Packaging Systems for Minimally Processed Fresh Greens

9. Conclusion

The demand for minimally processed salad, particularly Spring Mix, has reached significant levels. However, the short shelf life of this product has created a need to develop a new packaging system that can extend its freshness. While various packaging processes have been developed, this research focuses on analyzing micro-perforation patterns as a potential solution. Previous studies have not fully addressed the determination of shelf life for fresh greens, presenting a gap that this research aims to fill.

The main objective of this study was to identify the micro-perforated film pattern that allows the most effective modification of gas exchange between the package and its headspace gases, ultimately extending the shelf life of the product. To achieve this goal, a quantitative research approach will be employed. The study will determine which micro-perforation pattern facilitates rapid modification of the headspace gases, leading to an increase in the shelf life of the Spring Mix.

In conclusion, the analysis of the tests conducted on three different types of microperforated films (control, variable 2, and variable 6). used for packaging Spring Mix provides valuable insights into their effectiveness in preserving antioxidants, minimizing leaf damage, and influencing titratable acidity and pH levels of the product.

Regarding antioxidants, microperforated variable 2 consistently demonstrated better preservation of antioxidants compared to the control and variable 6. However, further analysis and experimentation are necessary to draw definitive conclusions and identify the underlying factors influencing these results. Factors such as storage conditions, initial antioxidant content, and interactions between the film and the Spring Mix should be considered in future research.

In terms of damaged leaves, microperforated film variable 6 consistently exhibited the lowest levels of leaf damage among the three films tested. It appeared to be more effective in protecting the Spring Mix leaves compared to the control group and the other microperforated films (V2 and V5). However, conducting further studies with proper data collection protocols would be necessary to investigate this relationship more effectively.

Regarding titratable acidity, the microperforated films showed varying effects on the acidity levels of the Spring Mix. The results were inconsistent across different test days, indicating that the influence of the films on titratable acidity varied. Further analysis and experimentation are required to understand the precise effects of microperforated films on the titratable acidity of the Spring Mix.

For pH levels, the microperforated films did not exhibit significant variations compared to the control group. The pH levels remained relatively stable across all test days and films, indicating that the films did not have a substantial impact on the pH of the Spring Mix.

In summary, the data suggests that microperforated variable 2 may be more effective in preserving antioxidants in the Spring Mix, microperforated film variable 6 may help minimize leaf damage, and the microperforated films may have varied effects on titratable acidity with no significant impact on pH levels. However, it is crucial to emphasize that further research and experimentation are necessary to confirm these findings and understand the underlying factors influencing these observations. The complex nature of the interactions between the film, the Spring Mix, and various environmental factors requires a more comprehensive investigation to develop an improved packaging system that can reliably extend the shelf life of minimally processed fresh-cut salads like Spring Mix.

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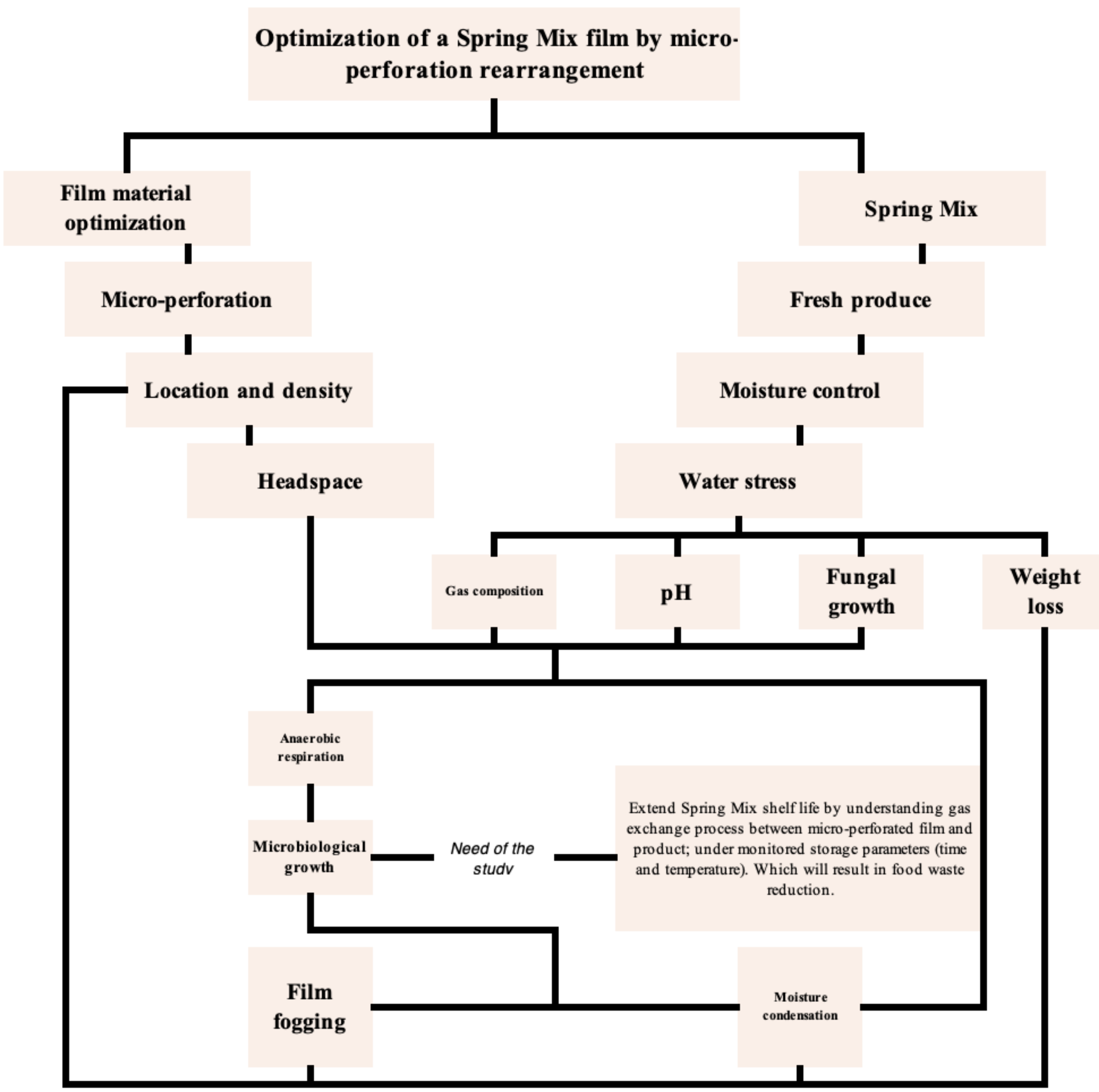
Appendix

Figure A1. Literature Map



Appendix B

Laboratory Protocol Sheet

Spring Mix Film Optimization

Lab protocol for sample taking and testing.

1) Go to lab and turn on headspace machine on (it will take 30 min to heat up)
2) Go to the freezer chamber and take pictures of the Spring Mix bags.
3) Relocate Spring Mix bags to the lab.

   Note: Do not pressure bags when transporting, make them stand up-right

4) Weight content
5) Measure headspace
   a. With the syringe take air out of the bag and allow for the equipment to take measurements
6) Sensory evaluation
   a. Open bag and spread content into aluminum foil.
      1.Make sure the product does not touch the table.
   b. Evaluate product.
      1.Remove wilting[1] leaves.
   c. Weight wilting leaves and discard
   d. Prepare sample for testing.
      1.Blend remaining product with 100 mL of distilled water for 30 sec.
      2.Fill separate container with water and ice.

---

[1] High moisture content, color change, aroma change, physical damage…

3.Place container with blended sample in the iced water container

4.Fill 2 vials with 10 grams (each) with the blended sample.

5.Freeze vials with liquid nitrogen[2]

6.Wrap vials in foil.

7.Label vial (with sample number, date, and initials)

8.Place vials in freezer (next room)

e. Test

1.Take pH levels[3]

2.Take acidity levels[4]

3.Take soluble solid levels[5]

[2] Follow Good Manufacturing Practice protocol to handle liquid nitrogen (gloves and face mask must be warn)
[3] Follow guidelines
[4] Follow guidelines
[5] Follow guidelines

Spring Mix Film Optimization

Protocol for pH levels measurements

1. Turn on pH-meter.
2. Make sure equipment is calibrated (see below)
3. Clean electrodes with distilled water
4. Take pH levels.
5. Clean electrodes with distilled water
6. Turn off.

Spring Mix Film Optimization

Protocol for pH-meter calibration

1. Turn off equipment.
2. Rinse the electrode with distilled water.
3. Dry electrode
4. Place electrode in the solution of pH 7.0 buffer, allow the display to stabilize.
5. Remove electrode.
6. Rinse with distilled water
7. Place electrode in the solution of pH 4.0 buffer, allow the display to stabilize.
8. Remove electrode.
9. Rinse with distilled water
10. Make sure equipment tells you is calibrated.

Spring Mix Film Optimization

Protocol for acidity levels measurements

1. Fill pipette with Sodium Hydroxide (NaOH)
2. Fill a beaker with 10 grams of blended sample and 100 mL of distilled water.
3. Insert electrode in the beaker.
4. Drop (slowly) NaOH into the beaker with the sample and stir (slowly)
5. Stop when it indicates a pH of 8.0.
6. Measure amount of NaOH needed to get pH 8.0.

Spring Mix Film Optimization

Protocol for Soluble Solid Levels measurement

1. Calibrate refractometer before each sample (see below)
2. Pour blended sample in the plate.
3. Measure
4. Clean with distilled water
5. Dry

Spring Mix Film Optimization

Protocol for Refractometer calibration

1. Pour distilled water in plate.
2. Make sure it measures 0, if not press the 0 bottom in the refractometer
3. Dry

* Make sure to wear gloves and safety glasses when testing!

Appendix C

Data Analisys

Appendix Table 1

One-way within-subjects (repeated measures)

ANOVA with LSD in SPSS

Within-Subjects Factors

Measure: MEASURE_1

Time	Dependent Variable
1	Day5
2	Day10
3	Day11
4	Day12
5	Day13
6	Day14
7	Day15
8	Day16
9	Day17

Appendix Table 2

Initial weight

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	154.195	.106	2
Day 10	154.195	.106	2
Day 11	154.825	2.864	2
Day 12	152.540	1.697	2
Day 13	153.260	3.705	2
Day 14	155.770	.989	2
Day 15	156.090	.085	2
Day 16	157.769	1.202	2
Day 17	156.535	1.039	2

Appendix Table 3

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	44.425	8	5.553	1.569	.269	.611
	Greenhouse-Geisser	44.425	1.000	44.425	1.569	.429	.611
	Huynh-Feldt	44.425	.000	.	.	.	.611
	Lower-bound	44.425	1.000	44.425	1.569	.429	.611
Error (Time)	Sphericity Assumed	28.315	8	3.539			
	Greenhouse-Geisser	28.315	1.000	28.315			
	Huynh-Feldt	28.315	.000	.			
	Lower-bound	28.315	1.000	28.315			

Appendix Table 4

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	.000	.000	.	.000	.000
	3	-.630	2.100	.814	-27.313	26.053
	4	1.655	1.275	.418	-14.545	17.855
	5	.935	2.545	.776	-31.402	33.272
	6	-1.575	.775	.291	-11.422	8.272
	7	-1.895*	.135	.045	-3.610	-.180
	8	-3.575	.775	.136	-13.422	6.272
	9	-2.340	.660	.175	-10.726	6.046
2	1	.000	.000	.	.000	.000
	3	-.630	2.100	.814	-27.313	26.053
	4	1.655	1.275	.418	-14.545	17.855
	5	.935	2.545	.776	-31.402	33.272
	6	-1.575	.775	.291	-11.422	8.272
	7	-1.895*	.135	.045	-3.610	-.180
	8	-3.575	.775	.136	-13.422	6.272

	9	-2.340	.660	.175	-10.726	6.046
3	1	.630	2.100	.814	-26.053	27.313
	2	.630	2.100	.814	-26.053	27.313
	4	2.285	.825	.221	-8.198	12.768
	5	1.565	4.645	.793	-57.455	60.585
	6	-.945	1.325	.606	-17.781	15.891
	7	-1.265	1.965	.636	-26.233	23.703
	8	-2.945	2.875	.492	-39.475	33.585
	9	-1.710	2.760	.647	-36.779	33.359
4	1	-1.655	1.275	.418	-17.855	14.545
	2	-1.655	1.275	.418	-17.855	14.545
	3	-2.285	.825	.221	-12.768	8.198
	5	-.720	3.820	.881	-49.258	47.818
	6	-3.230	.500	.098	-9.583	3.123
	7	-3.550	1.140	.198	-18.035	10.935
	8	-5.230	2.050	.238	-31.278	20.818
	9	-3.995	1.935	.287	-28.582	20.592
5	1	-.935	2.545	.776	-33.272	31.402
	2	-.935	2.545	.776	-33.272	31.402
	3	-1.565	4.645	.793	-60.585	57.455
	4	.720	3.820	.881	-47.818	49.258
	6	-2.510	3.320	.588	-44.695	39.675

	7	-2.830	2.680	.483	-36.883	31.223
	8	-4.510	1.770	.238	-27.000	17.980
	9	-3.275	1.885	.332	-27.226	20.676
6	1	1.575	.775	.291	-8.272	11.422
	2	1.575	.775	.291	-8.272	11.422
	3	.945	1.325	.606	-15.891	17.781
	4	3.230	.500	.098	-3.123	9.583
	5	2.510	3.320	.588	-39.675	44.695
	7	-.320	.640	.705	-8.452	7.812
	8	-2.000	1.550	.420	-21.695	17.695
	9	-.765	1.435	.688	-18.998	17.468
7	1	1.895*	.135	.045	.180	3.610
	2	1.895*	.135	.045	.180	3.610
	3	1.265	1.965	.636	-23.703	26.233
	4	3.550	1.140	.198	-10.935	18.035
	5	2.830	2.680	.483	-31.223	36.883
	6	.320	.640	.705	-7.812	8.452
	8	-1.680	.910	.316	-13.243	9.883
	9	-.445	.795	.675	-10.546	9.656
8	1	3.575	.775	.136	-6.272	13.422
	2	3.575	.775	.136	-6.272	13.422
	3	2.945	2.875	.492	-33.585	39.475

	4	5.230	2.050	.238	-20.818	31.278
	5	4.510	1.770	.238	-17.980	27.000
	6	2.000	1.550	.420	-17.695	21.695
	7	1.680	.910	.316	-9.883	13.243
	9	1.235	.115	.059	-.226	2.696
9	1	2.340	.660	.175	-6.046	10.726
	2	2.340	.660	.175	-6.046	10.726
	3	1.710	2.760	.647	-33.359	36.779
	4	3.995	1.935	.287	-20.592	28.582
	5	3.275	1.885	.332	-20.676	27.226
	6	.765	1.435	.688	-17.468	18.998
	7	.445	.795	.675	-9.656	10.546
	8	-1.235	.115	.059	-2.696	.226

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 5

Final weight

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	153.883	.094	2
Day 10	154.108	.129	2
Day 11	154.003	2.619	2
Day 12	153.864	.703	2
Day 13	153.724	4.025	2
Day 14	155.392	.907	2
Day 15	155.085	.775	2
Day 16	155.992	1.709	2
Day 17	154.342	2.204	2

Appendix Table 6

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	10.346	8	1.293	.361	.914	.265
	Greenhouse-Geisser	10.346	1.000	10.346	.361	.655	.265
	Huynh-Feldt	10.346	.000	.	.	.	.265
	Lower-bound	10.346	1.000	10.346	.361	.655	.265
Error(Time)	Sphericity Assumed	28.624	8	3.578			
	Greenhouse-Geisser	28.624	1.000	28.624			
	Huynh-Feldt	28.624	.000	.			
	Lower-bound	28.624	1.000	28.624			

Appendix Table 7

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	-.225	.025	.070	-.543	.093
	3	-.120	1.918	.960	-24.495	24.255
	4	.020	.430	.971	-5.449	5.489
	5	.159	2.779	.964	-35.153	35.472
	6	-1.508	.708	.280	-10.509	7.492
	7	-1.202	.482	.243	-7.322	4.918
	8	-2.108	1.142	.316	-16.615	12.398
	9	-.458	1.492	.810	-19.412	18.495
2	1	.225	.025	.070	-.093	.543
	3	.105	1.943	.966	-24.587	24.797
	4	.245	.405	.654	-4.907	5.396
	5	.384	2.754	.912	-34.611	35.379
	6	-1.283	.733	.330	-10.601	8.035
	7	-.977	.457	.278	-6.779	4.826
	8	-1.883	1.117	.341	-16.072	12.305

	9	-.233	1.467	.900	-18.869	18.402
3	1	.120	1.918	.960	-24.255	24.495
	2	-.105	1.943	.966	-24.797	24.587
	4	.140	2.349	.962	-29.704	29.983
	5	.279	4.697	.962	-59.408	59.967
	6	-1.388	1.210	.456	-16.763	13.986
	7	-1.082	2.400	.730	-31.577	29.413
	8	-1.988	3.060	.633	-40.869	36.893
	9	-.338	3.410	.937	-43.666	42.990
4	1	-.020	.430	.971	-5.489	5.449
	2	-.245	.405	.654	-5.396	4.907
	3	-.140	2.349	.962	-29.983	29.704
	5	.140	2.349	.962	-29.704	29.983
	6	-1.528	1.139	.408	-15.997	12.941
	7	-1.221*	.051	.027	-1.872	-.570
	8	-2.128	.711	.205	-11.165	6.909
	9	-.478	1.061	.731	-13.962	13.007
5	1	-.159	2.779	.964	-35.472	35.153
	2	-.384	2.754	.912	-35.379	34.611
	3	-.279	4.697	.962	-59.967	59.408
	4	-.140	2.349	.962	-29.983	29.704
	6	-1.668	3.488	.716	-45.980	42.645

	7	-1.361	2.297	.660	-30.553	27.832
	8	-2.268	1.637	.398	-23.074	18.539
	9	-.618	1.287	.715	-16.977	15.742
6	1	1.508	.708	.280	-7.492	10.509
	2	1.283	.733	.330	-8.035	10.601
	3	1.388	1.210	.456	-13.986	16.763
	4	1.528	1.139	.408	-12.941	15.997
	5	1.668	3.488	.716	-42.645	45.980
	7	.307	1.190	.839	-14.814	15.427
	8	-.600	1.850	.800	-24.106	22.906
	9	1.050	2.200	.717	-26.904	29.004
7	1	1.202	.482	.243	-4.918	7.322
	2	.977	.457	.278	-4.826	6.779
	3	1.082	2.400	.730	-29.413	31.577
	4	1.221*	.051	.027	.570	1.872
	5	1.361	2.297	.660	-27.832	30.553
	6	-.307	1.190	.839	-15.427	14.814
	8	-.907	.660	.401	-9.293	7.479
	9	.743	1.010	.596	-12.090	13.577
8	1	2.108	1.142	.316	-12.398	16.615
	2	1.883	1.117	.341	-12.305	16.072
	3	1.988	3.060	.633	-36.893	40.869

	4	2.128	.711	.205	-6.909	11.165
	5	2.268	1.637	.398	-18.539	23.074
	6	.600	1.850	.800	-22.906	24.106
	7	.907	.660	.401	-7.479	9.293
	9	1.650	.350	.133	-2.797	6.097
9	1	.458	1.492	.810	-18.495	19.412
	2	.233	1.467	.900	-18.402	18.869
	3	.338	3.410	.937	-42.990	43.666
	4	.478	1.061	.731	-13.007	13.962
	5	.618	1.287	.715	-15.742	16.977
	6	-1.050	2.200	.717	-29.004	26.904
	7	-.743	1.010	.596	-13.577	12.090
	8	-1.650	.350	.133	-6.097	2.797

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 8

Weight difference

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	.308	.012	2
Day 10	.083	.024	2
Day 11	.822	.245	2
Day 12	.179	.280	2
Day 13	-.463	.316	2
Day 14	.375	.082	2
Day 15	1.007	.858	2
Day 16	1.775	.507	2
Day 17	2.192	1.167	2

Appendix Table 9

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared

Time	Sphericity Assumed	11.507	8	1.438	9.100	.003	.901
	Greenhouse-Geisser	11.507	1.000	11.507	9.100	.204	.901
	Huynh-Feldt	11.507	.000	.	.	.	.901
	Lower-bound	11.507	1.000	11.507	9.100	.204	.901
Error(Time)	Sphericity Assumed	1.264	8	.158			
	Greenhouse-Geisser	1.264	1.000	1.264			
	Huynh-Feldt	1.264	.000	.			
	Lower-bound	1.264	1.000	1.264			

Table 10

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	.225	.025	.070	-.093	.543
	3	-.513	.182	.217	-2.822	1.795
	4	.129	.207	.644	-2.497	2.755
	5	.772	.232	.186	-2.172	3.715
	6	-.067	.067	.500	-.914	.780
	7	-.698	.615	.460	-8.513	7.116
	8	-1.467	.367	.156	-6.126	3.192
	9	-1.883	.833	.265	-12.472	8.705
2	1	-.225	.025	.070	-.543	.093
	3	-.738	.157	.133	-2.729	1.252
	4	-.096	.182	.691	-2.404	2.212
	5	.547	.207	.230	-2.079	3.173
	6	-.292	.042	.090	-.821	.238
	7	-.923	.590	.362	-8.420	6.573
	8	-1.692	.342	.127	-6.033	2.650

	9	-2.108	.808	.233	-12.379	8.163
3	1	.513	.182	.217	-1.795	2.822
	2	.738	.157	.133	-1.252	2.729
	4	.642*	.025	.025	.325	.960
	5	1.285*	.050	.025	.650	1.920
	6	.447	.115	.160	-1.015	1.908
	7	-.185	.433	.743	-5.691	5.321
	8	-.953	.185	.122	-3.304	1.397
	9	-1.370	.652	.283	-9.650	6.910
4	1	-.129	.207	.644	-2.755	2.497
	2	.096	.182	.691	-2.212	2.404
	3	-.642*	.025	.025	-.960	-.325
	5	.643*	.025	.025	.325	.960
	6	-.196	.140	.395	-1.975	1.583
	7	-.827	.408	.292	-6.016	4.361
	8	-1.596	.160	.064	-3.629	.437
	9	-2.012	.627	.192	-9.975	5.950
5	1	-.772	.232	.186	-3.715	2.172
	2	-.547	.207	.230	-3.173	2.079
	3	-1.285*	.050	.025	-1.920	-.650
	4	-.643*	.025	.025	-.960	-.325
	6	-.838	.165	.124	-2.935	1.258

	7	-1.470	.383	.162	-6.341	3.401
	8	-2.238*	.135	.038	-3.954	-.523
	9	-2.655	.602	.142	-10.300	4.990
6	1	.067	.067	.500	-.780	.914
	2	.292	.042	.090	-.238	.821
	3	-.447	.115	.160	-1.908	1.015
	4	.196	.140	.395	-1.583	1.975
	5	.838	.165	.124	-1.258	2.935
	7	-.632	.548	.455	-7.599	6.336
	8	-1.400	.300	.134	-5.212	2.412
	9	-1.817	.767	.254	-11.558	7.925
7	1	.698	.615	.460	-7.116	8.513
	2	.923	.590	.362	-6.573	8.420
	3	.185	.433	.743	-5.321	5.691
	4	.827	.408	.292	-4.361	6.016
	5	1.470	.383	.162	-3.401	6.341
	6	.632	.548	.455	-6.336	7.599
	8	-.768	.248	.199	-3.924	2.387
	9	-1.185	.218	.116	-3.959	1.589
8	1	1.467	.367	.156	-3.192	6.126
	2	1.692	.342	.127	-2.650	6.033
	3	.953	.185	.122	-1.397	3.304

	4	1.596	.160	.064	-.437	3.629
	5	2.238*	.135	.038	.523	3.954
	6	1.400	.300	.134	-2.412	5.212
	7	.768	.248	.199	-2.387	3.924
	9	-.417	.467	.536	-6.346	5.513
9	1	1.883	.833	.265	-8.705	12.472
	2	2.108	.808	.233	-8.163	12.379
	3	1.370	.652	.283	-6.910	9.650
	4	2.012	.627	.192	-5.950	9.975
	5	2.655	.602	.142	-4.990	10.300
	6	1.817	.767	.254	-7.925	11.558
	7	1.185	.218	.116	-1.589	3.959
	8	.417	.467	.536	-5.513	6.346

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 11

Headspace

a. **O_2**

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	20.900	.0000	2
Day 10	20.300	.8485	2
Day 11	20.900	.0000	2
Day 12	20.900	.0000	2
Day 13	20.300	.8485	2
Day 14	20.900	.0000	2
Day 15	20.900	.0000	2
Day 16	20.900	.0000	2
Day 17	20.900	.0000	2

Appendix Table 12

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1.120	8	.140	1.000	.500	.500
	Greenhouse-Geisser	1.120	1.000	1.120	1.000	.500	.500
	Huynh-Feldt	1.120	.	.	.	.	.500
	Lower-bound	1.120	1.000	1.120	1.000	.500	.500
Error(Time)	Sphericity Assumed	1.120	8	.140			
	Greenhouse-Geisser	1.120	1.000	1.120			
	Huynh-Feldt	1.120	.	.			
	Lower-bound	1.120	1.000	1.120			

Appendix Table 13

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
1	2	.600	.600	.500	-7.024	8.224
	3	.000	.000	.	.000	.000
	4	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
2	1	-.600	.600	.500	-8.224	7.024
	3	-.600	.600	.500	-8.224	7.024
	4	-.600	.600	.500	-8.224	7.024
	5	.000	.000	.	.000	.000
	6	-.600	.600	.500	-8.224	7.024
	7	-.600	.600	.500	-8.224	7.024
	8	-.600	.600	.500	-8.224	7.024

	9	-.600	.600	.500	-8.224	7.024
3	1	.000	.000	.	.000	.000
	2	.600	.600	.500	-7.024	8.224
	4	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
4	1	.000	.000	.	.000	.000
	2	.600	.600	.500	-7.024	8.224
	3	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
5	1	-.600	.600	.500	-8.224	7.024
	2	.000	.000	.	.000	.000
	3	-.600	.600	.500	-8.224	7.024
	4	-.600	.600	.500	-8.224	7.024
	6	-.600	.600	.500	-8.224	7.024

	7	-.600	.600	.500	-8.224	7.024
	8	-.600	.600	.500	-8.224	7.024
	9	-.600	.600	.500	-8.224	7.024
6	1	.000	.000	.	.000	.000
	2	.600	.600	.500	-7.024	8.224
	3	.000	.000	.	.000	.000
	4	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
7	1	.000	.000	.	.000	.000
	2	.600	.600	.500	-7.024	8.224
	3	.000	.000	.	.000	.000
	4	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	6	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
8	1	.000	.000	.	.000	.000
	2	.600	.600	.500	-7.024	8.224
	3	.000	.000	.	.000	.000

	4	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
9	1	.000	.000	.	.000	.000
	2	.600	.600	.500	-7.024	8.224
	3	.000	.000	.	.000	.000
	4	.000	.000	.	.000	.000
	5	.600	.600	.500	-7.024	8.224
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 14

CO2

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	-.100	.1414	2
Day 10	.700	.9899	2
Day 11	-.100	.1414	2
Day 12	-.100	.1414	2
Day 13	.700	.9899	2
Day 14	.00	.000	2
Day 15	.00	.000	2
Day 16	.00	.000	2
Day 17	.00	.000	2

Appendix Table 15

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1.751	8	.219	1.271	.371	.560
	Greenhouse-Geisser	1.751	1.000	1.751	1.271	.462	.560
	Huynh-Feldt	1.751	.	.	.	.	.560
	Lower-bound	1.751	1.000	1.751	1.271	.462	.560
Error(Time)	Sphericity Assumed	1.378	8	.172			
	Greenhouse-Geisser	1.378	1.000	1.378			
	Huynh-Feldt	1.378	.	.			
	Lower-bound	1.378	1.000	1.378			

Appendix Table 16

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
1	2	-.800	.600	.410	-8.424	6.824
	3	.000	.000	.	.000	.000
	4	.000	.000	.	.000	.000
	5	-.800	.600	.410	-8.424	6.824
	6	-.100	.100	.500	-1.371	1.171
	7	-.100	.100	.500	-1.371	1.171
	8	-.100	.100	.500	-1.371	1.171
	9	-.100	.100	.500	-1.371	1.171
2	1	.800	.600	.410	-6.824	8.424
	3	.800	.600	.410	-6.824	8.424
	4	.800	.600	.410	-6.824	8.424
	5	.000	.000	.	.000	.000
	6	.700	.700	.500	-8.194	9.594
	7	.700	.700	.500	-8.194	9.594
	8	.700	.700	.500	-8.194	9.594

	9	.700	.700	.500	-8.194	9.594
3	1	.000	.000	.	.000	.000
	2	-.800	.600	.410	-8.424	6.824
	4	.000	.000	.	.000	.000
	5	-.800	.600	.410	-8.424	6.824
	6	-.100	.100	.500	-1.371	1.171
	7	-.100	.100	.500	-1.371	1.171
	8	-.100	.100	.500	-1.371	1.171
	9	-.100	.100	.500	-1.371	1.171
4	1	.000	.000	.	.000	.000
	2	-.800	.600	.410	-8.424	6.824
	3	.000	.000	.	.000	.000
	5	-.800	.600	.410	-8.424	6.824
	6	-.100	.100	.500	-1.371	1.171
	7	-.100	.100	.500	-1.371	1.171
	8	-.100	.100	.500	-1.371	1.171
	9	-.100	.100	.500	-1.371	1.171
5	1	.800	.600	.410	-6.824	8.424
	2	.000	.000	.	.000	.000
	3	.800	.600	.410	-6.824	8.424
	4	.800	.600	.410	-6.824	8.424
	6	.700	.700	.500	-8.194	9.594

	7	.700	.700	.500	-8.194	9.594
	8	.700	.700	.500	-8.194	9.594
	9	.700	.700	.500	-8.194	9.594
6	1	.100	.100	.500	-1.171	1.371
	2	-.700	.700	.500	-9.594	8.194
	3	.100	.100	.500	-1.171	1.371
	4	.100	.100	.500	-1.171	1.371
	5	-.700	.700	.500	-9.594	8.194
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
7	1	.100	.100	.500	-1.171	1.371
	2	-.700	.700	.500	-9.594	8.194
	3	.100	.100	.500	-1.171	1.371
	4	.100	.100	.500	-1.171	1.371
	5	-.700	.700	.500	-9.594	8.194
	6	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
8	1	.100	.100	.500	-1.171	1.371
	2	-.700	.700	.500	-9.594	8.194
	3	.100	.100	.500	-1.171	1.371

	4	.100	.100	.500	-1.171	1.371
	5	-.700	.700	.500	-9.594	8.194
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
9	1	.100	.100	.500	-1.171	1.371
	2	-.700	.700	.500	-9.594	8.194
	3	.100	.100	.500	-1.171	1.371
	4	.100	.100	.500	-1.171	1.371
	5	-.700	.700	.500	-9.594	8.194
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 17

N2

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	79.199	.141	2
Day 10	79.300	.283	2
Day 11	79.199	.141	2
Day 12	79.199	.141	2
Day 13	79.300	.283	2
Day 14	79.100	.000	2
Day 15	79.100	.000	2
Day 16	79.100	.000	2
Day 17	79.100	.000	2

Appendix Table 18

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	.111	8	.014	.510	.820	.338
	Greenhouse-Geisser	.111	1.000	.111	.510	.605	.338
	Huynh-Feldt	.111	.	.	.	.	.338
	Lower-bound	.111	1.000	.111	.510	.605	.338
Error(Time)	Sphericity Assumed	.218	8	.027			
	Greenhouse-Geisser	.218	1.000	.218			
	Huynh-Feldt	.218	.	.			
	Lower-bound	.218	1.000	.218			

Appendix Table 19

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
1	2	-.100	.300	.795	-3.912	3.712
	3	.000	.000	.	.000	.000
	4	.000	.000	.	.000	.000
	5	-.100	.300	.795	-3.912	3.712
	6	.100	.100	.500	-1.171	1.371
	7	.100	.100	.500	-1.171	1.371
	8	.100	.100	.500	-1.171	1.371
	9	.100	.100	.500	-1.171	1.371
2	1	.100	.300	.795	-3.712	3.912
	3	.100	.300	.795	-3.712	3.912
	4	.100	.300	.795	-3.712	3.912
	5	.000	.000	.	.000	.000
	6	.200	.200	.500	-2.341	2.741
	7	.200	.200	.500	-2.341	2.741

	8	.200	.200	.500	-2.341	2.741
	9	.200	.200	.500	-2.341	2.741
3	1	.000	.000	.	.000	.000
	2	-.100	.300	.795	-3.912	3.712
	4	.000	.000	.	.000	.000
	5	-.100	.300	.795	-3.912	3.712
	6	.100	.100	.500	-1.171	1.371
	7	.100	.100	.500	-1.171	1.371
	8	.100	.100	.500	-1.171	1.371
	9	.100	.100	.500	-1.171	1.371
4	1	.000	.000	.	.000	.000
	2	-.100	.300	.795	-3.912	3.712
	3	.000	.000	.	.000	.000
	5	-.100	.300	.795	-3.912	3.712
	6	.100	.100	.500	-1.171	1.371
	7	.100	.100	.500	-1.171	1.371
	8	.100	.100	.500	-1.171	1.371
	9	.100	.100	.500	-1.171	1.371
5	1	.100	.300	.795	-3.712	3.912
	2	.000	.000	.	.000	.000
	3	.100	.300	.795	-3.712	3.912
	4	.100	.300	.795	-3.712	3.912

	6	.200	.200	.500	-2.341	2.741
	7	.200	.200	.500	-2.341	2.741
	8	.200	.200	.500	-2.341	2.741
	9	.200	.200	.500	-2.341	2.741
6	1	-.100	.100	.500	-1.371	1.171
	2	-.200	.200	.500	-2.741	2.341
	3	-.100	.100	.500	-1.371	1.171
	4	-.100	.100	.500	-1.371	1.171
	5	-.200	.200	.500	-2.741	2.341
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
7	1	-.100	.100	.500	-1.371	1.171
	2	-.200	.200	.500	-2.741	2.341
	3	-.100	.100	.500	-1.371	1.171
	4	-.100	.100	.500	-1.371	1.171
	5	-.200	.200	.500	-2.741	2.341
	6	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
8	1	-.100	.100	.500	-1.371	1.171
	2	-.200	.200	.500	-2.741	2.341

	3	-.100	.100	.500	-1.371	1.171
	4	-.100	.100	.500	-1.371	1.171
	5	-.200	.200	.500	-2.741	2.341
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	9	.000	.000	.	.000	.000
9	1	-.100	.100	.500	-1.371	1.171
	2	-.200	.200	.500	-2.741	2.341
	3	-.100	.100	.500	-1.371	1.171
	4	-.100	.100	.500	-1.371	1.171
	5	-.200	.200	.500	-2.741	2.341
	6	.000	.000	.	.000	.000
	7	.000	.000	.	.000	.000
	8	.000	.000	.	.000	.000

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 20

Damaged leaves (g)

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	.308	.0118	2
Day 10	.508	.507	2
Day 11	29.008	15.898	2
Day 12	31.775	15.379	2
Day 13	32.458	18.255	2
Day 14	33.244	20.121	2
Day 15	34.462	19.886	2
Day 16	38.310	18.959	2
Day 17	36.675	18.679	2

Appendix Table 21

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	3565.455	8	445.682	6.503	.008	.867
	Greenhouse-Geisser	3565.455	1.000	3565.455	6.503	.238	.867
	Huynh-Feldt	3565.455	.000	.	.	.	.867
	Lower-bound	3565.455	1.000	3565.455	6.503	.238	.867
Error(Time)	Sphericity Assumed	548.284	8	68.536			
	Greenhouse-Geisser	548.284	1.000	548.284			
	Huynh-Feldt	548.284	.000	.			
	Lower-bound	548.284	1.000	548.284			

Appendix Table 22

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.200	.367	.682	-4.859	4.459
	3	-28.700	11.233	.238	-171.433	114.033
	4	-31.467	10.867	.212	-169.541	106.607
	5	-32.150	12.900	.243	-196.060	131.760
	6	-32.936	14.219	.259	-213.607	147.736
	7	-34.153	14.053	.249	-212.718	144.411
	8	-38.002	13.398	.216	-208.244	132.240
	9	-36.367	13.200	.222	-204.089	131.355
2	1	.200	.367	.682	-4.459	4.859
	3	-28.500	11.600	.246	-175.892	118.892
	4	-31.267	11.233	.220	-174.000	111.466
	5	-31.950	13.267	.251	-200.519	136.619
	6	-32.736	14.586	.267	-218.066	152.595
	7	-33.953	14.420	.256	-217.177	149.270
	8	-37.802	13.765	.222	-212.703	137.099

	9	-36.167	13.567	.228	-208.548	136.214
3	1	28.700	11.233	.238	-114.033	171.433
	2	28.500	11.600	.246	-118.892	175.892
	4	-2.767	.367	.084	-7.426	1.892
	5	-3.450	1.667	.286	-24.627	17.727
	6	-4.236	2.986	.391	-42.174	33.703
	7	-5.453	2.820	.304	-41.285	30.378
	8	-9.302	2.165	.146	-36.811	18.207
	9	-7.667	1.967	.160	-32.656	17.322
4	1	31.467	10.867	.212	-106.607	169.541
	2	31.267	11.233	.220	-111.466	174.000
	3	2.767	.367	.084	-1.892	7.426
	5	-.683	2.033	.794	-26.519	25.153
	6	-1.469	3.352	.737	-44.067	41.128
	7	-2.687	3.187	.554	-43.177	37.804
	8	-6.535	2.532	.235	-38.703	25.633
	9	-4.900	2.333	.283	-34.548	24.748
5	1	32.150	12.900	.243	-131.760	196.060
	2	31.950	13.267	.251	-136.619	200.519
	3	3.450	1.667	.286	-17.727	24.627
	4	.683	2.033	.794	-25.153	26.519
	6	-.786	1.319	.658	-17.547	15.976

	7	-2.003	1.153	.333	-16.658	12.651
	8	-5.852	.498	.054	-12.184	.480
	9	-4.217*	.300	.045	-8.029	-.405
6	1	32.936	14.219	.259	-147.736	213.607
	2	32.736	14.586	.267	-152.595	218.066
	3	4.236	2.986	.391	-33.703	42.174
	4	1.469	3.352	.737	-41.128	44.067
	5	.786	1.319	.658	-15.976	17.547
	7	-1.218	.166	.086	-3.325	.890
	8	-5.066	.821	.102	-15.496	5.364
	9	-3.431	1.019	.184	-16.381	9.519
7	1	34.153	14.053	.249	-144.411	212.718
	2	33.953	14.420	.256	-149.270	217.177
	3	5.453	2.820	.304	-30.378	41.285
	4	2.687	3.187	.554	-37.804	43.177
	5	2.003	1.153	.333	-12.651	16.658
	6	1.218	.166	.086	-.890	3.325
	8	-3.848	.655	.107	-12.171	4.474
	9	-2.213	.853	.234	-13.056	8.629
8	1	38.002	13.398	.216	-132.240	208.244
	2	37.802	13.765	.222	-137.099	212.703
	3	9.302	2.165	.146	-18.207	36.811

	4	6.535	2.532	.235	-25.633	38.703
	5	5.852	.498	.054	-.480	12.184
	6	5.066	.821	.102	-5.364	15.496
	7	3.848	.655	.107	-4.474	12.171
	9	1.635	.198	.077	-.885	4.155
9	1	36.367	13.200	.222	-131.355	204.089
	2	36.167	13.567	.228	-136.214	208.548
	3	7.667	1.967	.160	-17.322	32.656
	4	4.900	2.333	.283	-24.748	34.548
	5	4.217*	.300	.045	.405	8.029
	6	3.431	1.019	.184	-9.519	16.381
	7	2.213	.853	.234	-8.629	13.056
	8	-1.635	.198	.077	-4.155	.885

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 23

Damaged leaves (%)

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	.1999	.008	2
Day 10	.329	.329	2
Day 11	18.834	10.617	2
Day 12	20.614	9.927	2
Day 13	21.041	11.402	2
Day 14	21.384	13.053	2
Day 15	22.081	12.752	2
Day 16	24.238	11.833	2
Day 17	23.390	11.778	2

Table 24 Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1462.114	8	182.764	6.545	.008	.867

	Greenhouse-Geisser	1462.114	1.000	1462.114	6.545	.237	.867
	Huynh-Feldt	1462.114	.000	.	.	.	.867
	Lower-bound	1462.114	1.000	1462.114	6.545	.237	.867
Error(Time)	Sphericity Assumed	223.384	8	27.923			
	Greenhouse-Geisser	223.384	1.000	223.384			
	Huynh-Feldt	223.384	.000	.			
	Lower-bound	223.384	1.000	223.384			

Appendix Table 25

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	-.130	.238	.682	-3.152	2.893
	3	-18.634	7.502	.244	-113.955	76.686
	4	-20.414	7.014	.211	-109.541	68.713
	5	-20.841	8.057	.235	-123.216	81.535
	6	-21.184	9.225	.261	-138.394	96.026
	7	-21.881	9.012	.249	-136.384	92.621
	8	-24.038	8.362	.213	-130.286	82.210
	9	-23.191	8.323	.219	-128.946	82.565
2	1	.130	.238	.682	-2.893	3.152
	3	-18.505	7.740	.252	-116.848	79.839
	4	-20.284	7.252	.219	-112.433	71.865
	5	-20.711	8.295	.243	-126.109	84.687
	6	-21.054	9.463	.269	-141.287	99.179
	7	-21.751	9.249	.256	-139.276	95.773
	8	-23.908	8.600	.220	-133.178	85.362

	9	-23.061	8.561	.226	-131.839	85.717
3	1	18.634	7.502	.244	-76.686	113.955
	2	18.505	7.740	.252	-79.839	116.848
	4	-1.779	.487	.170	-7.973	4.415
	5	-2.206	.555	.157	-9.261	4.848
	6	-2.549	1.723	.378	-24.439	19.340
	7	-3.247	1.510	.277	-22.428	15.935
	8	-5.403	.860	.100	-16.330	5.524
	9	-4.556	.821	.114	-14.991	5.879
4	1	20.414	7.014	.211	-68.713	109.541
	2	20.284	7.252	.219	-71.865	112.433
	3	1.779	.487	.170	-4.415	7.973
	5	-.427	1.043	.753	-13.675	12.822
	6	-.770	2.210	.787	-28.853	27.313
	7	-1.467	1.997	.597	-26.843	23.908
	8	-3.624	1.347	.227	-20.745	13.497
	9	-2.777	1.309	.280	-19.405	13.852
5	1	20.841	8.057	.235	-81.535	123.216
	2	20.711	8.295	.243	-84.687	126.109
	3	2.206	.555	.157	-4.848	9.261
	4	.427	1.043	.753	-12.822	13.675
	6	-.343	1.168	.818	-15.178	14.492

	7	-1.041	.954	.472	-13.168	11.086
	8	-3.197	.305	.061	-7.070	.675
	9	-2.350	.266	.072	-5.730	1.030
6	1	21.184	9.225	.261	-96.026	138.394
	2	21.054	9.463	.269	-99.179	141.287
	3	2.549	1.723	.378	-19.340	24.439
	4	.770	2.210	.787	-27.313	28.853
	5	.343	1.168	.818	-14.492	15.178
	7	-.697	.213	.189	-3.405	2.010
	8	-2.854	.863	.187	-13.816	8.108
	9	-2.007	.901	.269	-13.461	9.448
7	1	21.881	9.012	.249	-92.621	136.384
	2	21.751	9.249	.256	-95.773	139.276
	3	3.247	1.510	.277	-15.935	22.428
	4	1.467	1.997	.597	-23.908	26.843
	5	1.041	.954	.472	-11.086	13.168
	6	.697	.213	.189	-2.010	3.405
	8	-2.156	.650	.186	-10.411	6.098
	9	-1.309	.688	.308	-10.056	7.438
8	1	24.038	8.362	.213	-82.210	130.286
	2	23.908	8.600	.220	-85.362	133.178
	3	5.403	.860	.100	-5.524	16.330

	4	3.624	1.347	.227	-13.497	20.745
	5	3.197	.305	.061	-.675	7.070
	6	2.854	.863	.187	-8.108	13.816
	7	2.156	.650	.186	-6.098	10.411
	9	.847*	.039	.029	.355	1.339
9	1	23.191	8.323	.219	-82.565	128.946
	2	23.061	8.561	.226	-85.717	131.839
	3	4.556	.821	.114	-5.879	14.991
	4	2.777	1.309	.280	-13.852	19.405
	5	2.350	.266	.072	-1.030	5.730
	6	2.007	.901	.269	-9.448	13.461
	7	1.309	.688	.308	-7.438	10.056
	8	-.847*	.039	.029	-1.339	-.355

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 26

Titratable acidity

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	262.588	10.610	2
Day 10	255.835	3.183	2
Day 11	101.284	5.305	2
Day 12	104.659	.531	2
Day 13	108.036	6.366	2
Day 14	71.274	5.306	2
Day 15	77.276	9.549	2
Day 16	77.276	18.037	2
Day 17	70.524	16.976	2

Appendix Table 27

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	95439.970	8	11929.996	164.619	.000	.994
	Greenhouse-Geisser	95439.970	1.000	95439.970	164.619	.050	.994
	Huynh-Feldt	95439.970	.000	.	.	.	.994
	Lower-bound	95439.970	1.000	95439.970	164.619	.050	.994
Error(Time)	Sphericity Assumed	579.761	8	72.470			
	Greenhouse-Geisser	579.761	1.000	579.761			
	Huynh-Feldt	579.761	.000	.			
	Lower-bound	579.761	1.000	579.761			

Appendix Table 28

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	6.752	9.753	.614	-117.175	130.679
	3	161.304*	3.751	.015	113.640	208.968
	4	157.928*	7.878	.032	57.833	258.022
	5	154.552*	12.004	.049	2.026	307.077
	6	191.314*	3.751	.012	143.650	238.978
	7	185.312*	.750	.003	175.779	194.845
	8	185.312*	5.252	.018	118.582	252.042
	9	192.064*	4.501	.015	134.867	249.261
2	1	-6.752	9.753	.614	-130.679	117.175
	3	154.552*	6.002	.025	78.289	230.814
	4	151.175*	1.876	.008	127.343	175.007
	5	147.799*	2.251	.010	119.201	176.398
	6	184.562*	6.002	.021	108.299	260.824
	7	178.560*	9.003	.032	64.166	292.953
	8	178.560	15.005	.053	-12.097	369.216

	9	185.312*	14.255	.049	4.188	366.436
3	1	-161.304*	3.751	.015	-208.968	-113.640
	2	-154.552*	6.002	.025	-230.814	-78.289
	4	-3.376	4.126	.563	-55.807	49.054
	5	-6.752	8.253	.563	-111.613	98.109
	6	30.010	.000	.	30.010	30.010
	7	24.008	3.001	.079	-14.123	62.139
	8	24.008	9.003	.228	-90.386	138.402
	9	30.760	8.253	.167	-74.101	135.621
4	1	-157.928*	7.878	.032	-258.022	-57.833
	2	-151.175*	1.876	.008	-175.007	-127.343
	3	3.376	4.126	.563	-49.054	55.807
	5	-3.376	4.126	.563	-55.807	49.054
	6	33.386	4.126	.078	-19.044	85.817
	7	27.384	7.127	.162	-63.178	117.946
	8	27.384	13.129	.285	-139.440	194.209
	9	34.136	12.379	.221	-123.155	191.428
5	1	-154.552*	12.004	.049	-307.077	-2.026
	2	-147.799*	2.251	.010	-176.398	-119.201
	3	6.752	8.253	.563	-98.109	111.613
	4	3.376	4.126	.563	-49.054	55.807
	6	36.762	8.253	.141	-68.099	141.623

	7	30.760	11.254	.223	-112.232	173.753
	8	30.760	17.256	.325	-188.495	250.015
	9	37.512	16.506	.264	-172.210	247.235
6	1	-191.314*	3.751	.012	-238.978	-143.650
	2	-184.562*	6.002	.021	-260.824	-108.299
	3	-30.010	.000	.	-30.010	-30.010
	4	-33.386	4.126	.078	-85.817	19.044
	5	-36.762	8.253	.141	-141.623	68.099
	7	-6.002	3.001	.295	-44.133	32.129
	8	-6.002	9.003	.626	-120.396	108.392
	9	.750	8.253	.942	-104.111	105.611
7	1	-185.312*	.750	.003	-194.845	-175.779
	2	-178.560*	9.003	.032	-292.953	-64.166
	3	-24.008	3.001	.079	-62.139	14.123
	4	-27.384	7.127	.162	-117.946	63.178
	5	-30.760	11.254	.223	-173.753	112.232
	6	6.002	3.001	.295	-32.129	44.133
	8	2.842E-14	6.002	1.000	-76.263	76.263
	9	6.752	5.252	.421	-59.978	73.482
8	1	-185.312*	5.252	.018	-252.042	-118.582
	2	-178.560	15.005	.053	-369.216	12.097
	3	-24.008	9.003	.228	-138.402	90.386

	4	-27.384	13.129	.285	-194.209	139.440
	5	-30.760	17.256	.325	-250.015	188.495
	6	6.002	9.003	.626	-108.392	120.396
	7	-2.842E-14	6.002	1.000	-76.263	76.263
	9	6.752	.750	.070	-2.781	16.285
9	1	-192.064*	4.501	.015	-249.261	-134.867
	2	-185.312*	14.255	.049	-366.436	-4.188
	3	-30.760	8.253	.167	-135.621	74.101
	4	-34.136	12.379	.221	-191.428	123.155
	5	-37.512	16.506	.264	-247.235	172.210
	6	-.750	8.253	.942	-105.611	104.111
	7	-6.752	5.252	.421	-73.482	59.978
	8	-6.752	.750	.070	-16.285	2.781

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 29

Titratable acidity (Dornic)

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	2.917	.118	2
Day 10	2.842	.035	2
Day 11	1.125	.059	2
Day 12	1.163	.006	2
Day 13	1.025	.012	2
Day 14	.800	.424	2
Day 15	.725	.365	2
Day 16	.860	.198	2
Day 17	.785	.191	2

Appendix Table 30

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	.075	.108	.614	-1.302	1.452
	3	1.792*	.042	.015	1.262	2.321
	4	1.754*	.088	.032	.642	2.866
	5	1.892*	.092	.031	.727	3.056
	6	2.117	.217	.065	-.636	4.870
	7	2.192	.175	.051	-.032	4.415
	8	2.057*	.057	.018	1.337	2.777
	9	2.132*	.052	.015	1.475	2.788
2	1	-.075	.108	.614	-1.452	1.302
	3	1.717*	.067	.025	.870	2.564
	4	1.679*	.021	.008	1.414	1.944
	5	1.817*	.017	.006	1.605	2.028
	6	2.042	.325	.100	-2.088	6.171
	7	2.117	.283	.085	-1.483	5.717
	8	1.982	.165	.053	-.115	4.078

	9	2.057*	.160	.049	.024	4.090
3	1	-1.792*	.042	.015	-2.321	-1.262
	2	-1.717*	.067	.025	-2.564	-.870
	4	-.038	.046	.563	-.620	.545
	5	.100	.050	.295	-.535	.735
	6	.325	.258	.428	-2.957	3.607
	7	.400	.217	.316	-2.353	3.153
	8	.265	.098	.226	-.984	1.514
	9	.340	.093	.171	-.846	1.526
4	1	-1.754*	.088	.032	-2.866	-.642
	2	-1.679*	.021	.008	-1.944	-1.414
	3	.038	.046	.563	-.545	.620
	5	.138*	.004	.019	.085	.190
	6	.363	.304	.444	-3.502	4.227
	7	.438	.263	.344	-2.898	3.773
	8	.303	.144	.283	-1.529	2.134
	9	.378	.139	.225	-1.391	2.146
5	1	-1.892*	.092	.031	-3.056	-.727
	2	-1.817*	.017	.006	-2.028	-1.605
	3	-.100	.050	.295	-.735	.535
	4	-.138*	.004	.019	-.190	-.085
	6	.225	.308	.599	-3.693	4.143

	7	.300	.267	.463	-3.088	3.688
	8	.165	.148	.466	-1.720	2.050
	9	.240	.143	.343	-1.581	2.061
6	1	-2.117	.217	.065	-4.870	.636
	2	-2.042	.325	.100	-6.171	2.088
	3	-.325	.258	.428	-3.607	2.957
	4	-.363	.304	.444	-4.227	3.502
	5	-.225	.308	.599	-4.143	3.693
	7	.075	.042	.323	-.454	.604
	8	-.060	.160	.772	-2.093	1.973
	9	.015	.165	.942	-2.082	2.112
7	1	-2.192	.175	.051	-4.415	.032
	2	-2.117	.283	.085	-5.717	1.483
	3	-.400	.217	.316	-3.153	2.353
	4	-.438	.263	.344	-3.773	2.898
	5	-.300	.267	.463	-3.688	3.088
	6	-.075	.042	.323	-.604	.454
	8	-.135	.118	.458	-1.639	1.369
	9	-.060	.123	.712	-1.627	1.507
8	1	-2.057*	.057	.018	-2.777	-1.337
	2	-1.982	.165	.053	-4.078	.115
	3	-.265	.098	.226	-1.514	.984

	4	-.303	.144	.283	-2.134	1.529
	5	-.165	.148	.466	-2.050	1.720
	6	.060	.160	.772	-1.973	2.093
	7	.135	.118	.458	-1.369	1.639
	9	.075*	.005	.042	.011	.139
9	1	-2.132*	.052	.015	-2.788	-1.475
	2	-2.057*	.160	.049	-4.090	-.024
	3	-.340	.093	.171	-1.526	.846
	4	-.378	.139	.225	-2.146	1.391
	5	-.240	.143	.343	-2.061	1.581
	6	-.015	.165	.942	-2.112	2.082
	7	.060	.123	.712	-1.507	1.627
	8	-.075*	.005	.042	-.139	-.011

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 31

pH level

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	6.058	.082	2
Day 10	6.075	.012	2
Day 11	6.292	.318	2
Day 12	6.221	.206	2
Day 13	6.150	.094	2
Day 14	6.317	.165	2
Day 15	6.283	.212	2
Day 16	6.136	.074	2
Day 17	6.184	.145	2

Appendix Table 32

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	.142	8	.018	.552	.790	.356
	Greenhouse-Geisser	.142	1.000	.142	.552	.593	.356
	Huynh-Feldt	.142	.	.	.	.	.356
	Lower-bound	.142	1.000	.142	.552	.593	.356
Error(Time)	Sphericity Assumed	.258	8	.032			
	Greenhouse-Geisser	.258	1.000	.258			
	Huynh-Feldt	.258	.	.			
	Lower-bound	.258	1.000	.258			

Appendix Table 33

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
1	2	-.017	.050	.795	-.652	.619
	3	-.233	.283	.561	-3.833	3.367
	4	-.162	.204	.572	-2.757	2.432
	5	-.092	.125	.597	-1.680	1.497
	6	-.258	.058	.141	-1.000	.483
	7	-.225	.092	.246	-1.390	.940
	8	-.077	.111	.612	-1.486	1.331
	9	-.126	.044	.215	-.687	.435
2	1	.017	.050	.795	-.619	.652
	3	-.217	.233	.524	-3.181	2.748
	4	-.146	.154	.518	-2.105	1.813
	5	-.075	.075	.500	-1.028	.878
	6	-.242	.108	.268	-1.618	1.135
	7	-.208	.142	.380	-2.008	1.592
	8	-.061	.061	.500	-.834	.712
	9	-.109	.094	.453	-1.306	1.087

3	1	.233	.283	.561	-3.367	3.833
	2	.217	.233	.524	-2.748	3.181
	4	.071	.079	.535	-.935	1.077
	5	.142	.158	.535	-1.870	2.153
	6	-.025	.342	.954	-4.366	4.316
	7	.008	.375	.986	-4.756	4.773
	8	.156	.173	.532	-2.036	2.348
	9	.107	.328	.798	-4.054	4.269
4	1	.162	.204	.572	-2.432	2.757
	2	.146	.154	.518	-1.813	2.105
	3	-.071	.079	.535	-1.077	.935
	5	.071	.079	.535	-.935	1.077
	6	-.096	.263	.777	-3.431	3.240
	7	-.062	.296	.867	-3.821	3.696
	8	.085	.093	.530	-1.101	1.271
	9	.037	.248	.907	-3.119	3.192
5	1	.092	.125	.597	-1.497	1.680
	2	.075	.075	.500	-.878	1.028
	3	-.142	.158	.535	-2.153	1.870
	4	-.071	.079	.535	-1.077	.935
	6	-.167	.183	.530	-2.496	2.163
	7	-.133	.217	.649	-2.886	2.620

	8	.014	.014	.500	-.166	.194
	9	-.034	.169	.873	-2.184	2.115
6	1	.258	.058	.141	-.483	1.000
	2	.242	.108	.268	-1.135	1.618
	3	.025	.342	.954	-4.316	4.366
	4	.096	.263	.777	-3.240	3.431
	5	.167	.183	.530	-2.163	2.496
	7	.033	.033	.500	-.390	.457
	8	.181	.169	.479	-1.969	2.330
	9	.133	.014	.068	-.048	.313
7	1	.225	.092	.246	-.940	1.390
	2	.208	.142	.380	-1.592	2.008
	3	-.008	.375	.986	-4.773	4.756
	4	.063	.296	.867	-3.696	3.821
	5	.133	.217	.649	-2.620	2.886
	6	-.033	.033	.500	-.457	.390
	8	.148	.203	.599	-2.426	2.721
	9	.099	.048	.284	-.504	.703
8	1	.077	.111	.612	-1.331	1.486
	2	.061	.061	.500	-.712	.834
	3	-.156	.173	.532	-2.348	2.036
	4	-.085	.093	.530	-1.271	1.101

	5	-.014	.014	.500	-.194	.166
	6	-.181	.169	.479	-2.330	1.969
	7	-.148	.203	.599	-2.721	2.426
	9	-.048	.155	.808	-2.018	1.921
9	1	.126	.044	.215	-.435	.687
	2	.109	.094	.453	-1.087	1.306
	3	-.107	.328	.798	-4.269	4.054
	4	-.037	.248	.907	-3.192	3.119
	5	.034	.169	.873	-2.115	2.184
	6	-.133	.014	.068	-.313	.048
	7	-.099	.048	.284	-.703	.504
	8	.048	.155	.808	-1.921	2.018

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 34

Solids level

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	.617	.094	2
Day 10	.508	.059	2
Day 11	.658	.295	2
Day 12	.496	.171	2
Day 13	.333	.047	2
Day 14	1.198	1.299	2
Day 15	1.266	.966	2
Day 16	.972	.196	2
Day 17	.893	.037	2

Appendix Table 35

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1.712	8	.214	1.020	.489	.505
	Greenhouse-Geisser	1.712	1.000	1.712	1.020	.497	.505
	Huynh-Feldt	1.712	.000	.	.	.	.505
	Lower-bound	1.712	1.000	1.712	1.020	.497	.505
Error(Time)	Sphericity Assumed	1.679	8	.210			
	Greenhouse-Geisser	1.679	1.000	1.679			
	Huynh-Feldt	1.679	.000	.			
	Lower-bound	1.679	1.000	1.679			

Appendix Table 36

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	.108	.025	.144	-.209	.426
	3	-.042	.142	.818	-1.842	1.758
	4	.121	.054	.268	-.567	.809
	5	.283	.033	.075	-.140	.707
	6	-.582	.852	.619	-11.403	10.240
	7	-.650	.617	.483	-8.485	7.185
	8	-.355	.072	.127	-1.266	.556
	9	-.276	.041	.094	-.795	.243
2	1	-.108	.025	.144	-.426	.209
	3	-.150	.167	.533	-2.268	1.968
	4	.012	.079	.900	-.993	1.018
	5	.175*	.008	.030	.069	.281
	6	-.690	.877	.575	-11.829	10.449
	7	-.758	.642	.447	-8.911	7.395
	8	-.463	.097	.131	-1.692	.765

	9	-.384*	.016	.026	-.585	-.183
3	1	.042	.142	.818	-1.758	1.842
	2	.150	.167	.533	-1.968	2.268
	4	.162	.087	.314	-.949	1.274
	5	.325	.175	.314	-1.899	2.549
	6	-.540	.710	.586	-9.561	8.481
	7	-.608	.475	.422	-6.644	5.427
	8	-.313	.070	.140	-1.203	.576
	9	-.234	.183	.421	-2.553	2.085
4	1	-.121	.054	.268	-.809	.567
	2	-.012	.079	.900	-1.018	.993
	3	-.162	.087	.314	-1.274	.949
	5	.162	.088	.314	-.949	1.274
	6	-.702	.798	.540	-10.836	9.431
	7	-.771	.562	.401	-7.918	6.376
	8	-.476*	.018	.023	-.698	-.253
	9	-.397	.095	.150	-1.604	.810
5	1	-.283	.033	.075	-.707	.140
	2	-.175*	.008	.030	-.281	-.069
	3	-.325	.175	.314	-2.549	1.899
	4	-.162	.088	.314	-1.274	.949
	6	-.865	.885	.507	-12.110	10.380

	7	-.933	.650	.387	-9.192	7.326
	8	-.638	.105	.104	-1.972	.696
	9	-.559*	.008	.009	-.654	-.464
6	1	.582	.852	.619	-10.240	11.403
	2	.690	.877	.575	-10.449	11.829
	3	.540	.710	.586	-8.481	9.561
	4	.702	.798	.540	-9.431	10.836
	5	.865	.885	.507	-10.380	12.110
	7	-.068	.235	.820	-3.054	2.918
	8	.227	.780	.820	-9.684	10.138
	9	.306	.893	.790	-11.034	11.646
7	1	.650	.617	.483	-7.185	8.485
	2	.758	.642	.447	-7.395	8.911
	3	.608	.475	.422	-5.427	6.644
	4	.771	.562	.401	-6.376	7.918
	5	.933	.650	.387	-7.326	9.192
	6	.068	.235	.820	-2.918	3.054
	8	.295	.545	.684	-6.630	7.220
	9	.374	.658	.671	-7.980	8.728
8	1	.355	.072	.127	-.556	1.266
	2	.463	.097	.131	-.765	1.692
	3	.313	.070	.140	-.576	1.203

	4	.476*	.018	.023	.253	.698
	5	.638	.105	.104	-.696	1.972
	6	-.227	.780	.820	-10.138	9.684
	7	-.295	.545	.684	-7.220	6.630
	9	.079	.113	.610	-1.350	1.509
9	1	.276	.041	.094	-.243	.795
	2	.384*	.016	.026	.183	.585
	3	.234	.183	.421	-2.085	2.553
	4	.397	.095	.150	-.810	1.604
	5	.559*	.008	.009	.464	.654
	6	-.306	.893	.790	-11.646	11.034
	7	-.374	.658	.671	-8.728	7.980
	8	-.079	.113	.610	-1.509	1.350

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 37

Antioxidants

Descriptive Statistics

	Mean	Std. Deviation	N
Day 1	1.681	.602	4
Day 10	1.079	.400938	4
Day 11	1.543	.397830	4
Day 12	1.842	.395681	4
Day 13	1.813	.214384	4
Day 14	1.323	.285930	4
Day 15	1.347	.208386	4
Day 16	1.513	.381618	4
Day 17	1.279	.131328	4

Appendix Table 38

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	2.117	8	.265	2.216	.063	.425
	Greenhouse-Geisser	2.117	2.268	.934	2.216	.180	.425
	Huynh-Feldt	2.117	8.000	.265	2.216	.063	.425
	Lower-bound	2.117	1.000	2.117	2.216	.233	.425
Error(Time)	Sphericity Assumed	2.867	24	.119			
	Greenhouse-Geisser	2.867	6.803	.421			
	Huynh-Feldt	2.867	24.000	.119			
	Lower-bound	2.867	3.000	.956			

Appendix Table 39

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
1	2	.601	.428	1.000	-4.348	5.551
	3	.138	.389	1.000	-4.358	4.635
	4	-.161	.181	1.000	-2.251	1.929
	5	-.132	.270	1.000	-3.252	2.988
	6	.358	.419	1.000	-4.487	5.203
	7	.335	.341	1.000	-3.613	4.282
	8	.168	.349	1.000	-3.869	4.205
	9	.402	.359	1.000	-3.754	4.558
2	1	-.601	.428	1.000	-5.551	4.348
	3	-.463	.063	.184	-1.188	.262
	4	-.762	.268	1.000	-3.867	2.342
	5	-.733	.196	1.000	-3.002	1.535
	6	-.243	.169	1.000	-2.198	1.711
	7	-.267	.189	1.000	-2.453	1.919
	8	-.433	.254	1.000	-3.370	2.503

	9	-.200	.215	1.000	-2.691	2.292
3	1	-.138	.389	1.000	-4.635	4.358
	2	.463	.063	.184	-.262	1.188
	4	-.299	.237	1.000	-3.038	2.440
	5	-.270	.190	1.000	-2.469	1.929
	6	.220	.209	1.000	-2.201	2.641
	7	.196	.175	1.000	-1.829	2.221
	8	.030	.272	1.000	-3.120	3.180
	9	.263	.230	1.000	-2.391	2.918
4	1	.161	.181	1.000	-1.929	2.251
	2	.763	.268	1.000	-2.342	3.867
	3	.299	.237	1.000	-2.440	3.038
	5	.029	.120	1.000	-1.354	1.413
	6	.519	.276	1.000	-2.678	3.716
	7	.496	.252	1.000	-2.422	3.413
	8	.329	.208	1.000	-2.071	2.730
	9	.563	.261	1.000	-2.451	3.576
5	1	.132	.270	1.000	-2.988	3.252
	2	.733	.196	1.000	-1.535	3.002
	3	.270	.190	1.000	-1.929	2.469
	4	-.029	.120	1.000	-1.413	1.354
	6	.490	.158	1.000	-1.337	2.317

	7	.466	.188	1.000	-1.712	2.645
	8	.300	.122	1.000	-1.105	1.705
	9	.533	.158	1.000	-1.292	2.359
6	1	-.358	.419	1.000	-5.203	4.487
	2	.243	.169	1.000	-1.711	2.198
	3	-.220	.209	1.000	-2.641	2.201
	4	-.519	.276	1.000	-3.716	2.678
	5	-.490	.158	1.000	-2.317	1.337
	7	-.024	.201	1.000	-2.351	2.303
	8	-.190	.153	1.000	-1.956	1.576
	9	.043	.121	1.000	-1.354	1.441
7	1	-.334	.341	1.000	-4.282	3.613
	2	.267	.189	1.000	-1.919	2.453
	3	-.196	.175	1.000	-2.221	1.829
	4	-.496	.252	1.000	-3.413	2.422
	5	-.466	.188	1.000	-2.645	1.712
	6	.024	.201	1.000	-2.303	2.351
	8	-.166	.285	1.000	-3.467	3.134
	9	.067	.121	1.000	-1.337	1.472
8	1	-.168	.349	1.000	-4.205	3.869
	2	.433	.254	1.000	-2.503	3.370
	3	-.030	.272	1.000	-3.180	3.120

	4	-.329	.208	1.000	-2.730	2.071
	5	-.300	.122	1.000	-1.705	1.105
	6	.190	.153	1.000	-1.576	1.956
	7	.166	.285	1.000	-3.134	3.467
	9	.233	.208	1.000	-2.172	2.639
9	1	-.402	.359	1.000	-4.558	3.754
	2	.200	.215	1.000	-2.292	2.691
	3	-.263	.230	1.000	-2.918	2.391
	4	-.563	.261	1.000	-3.576	2.451
	5	-.533	.158	1.000	-2.359	1.292
	6	-.043	.121	1.000	-1.441	1.354
	7	-.067	.121	1.000	-1.472	1.337
	8	-.233	.208	1.000	-2.639	2.172

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Appendix Table 40

Variable 2

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	1.09600	.565607	4
Day 10	.71150	.338040	4
Day 11	1.587100	.2257343	4
Day 12	.927100	.2331331	4
Day 13	1.210425	.3610508	4
Day 14	.754175	.1740270	4
Day 15	1.348725	.1215329	4
Day 16	1.564575	.3318218	4
Day 17	1.349175	.0993347	4

Appendix Table 41

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	3.372	8	.421	4.942	.001	.622
	Greenhouse-Geisser	3.372	2.309	1.460	4.942	.043	.622
	Huynh-Feldt	3.372	8.000	.421	4.942	.001	.622
	Lower-bound	3.372	1.000	3.372	4.942	.113	.622
Error(Time)	Sphericity Assumed	2.047	24	.085			
	Greenhouse-Geisser	2.047	6.926	.296			
	Huynh-Feldt	2.047	24.000	.085			
	Lower-bound	2.047	3.000	.682			

Appendix Table 42

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	.385	.244	.213	-.392	1.161
	3	-.491	.312	.214	-1.485	.503
	4	.169	.169	.391	-.369	.707
	5	-.114	.339	.758	-1.195	.966
	6	.342	.330	.377	-.710	1.394
	7	-.253	.309	.473	-1.235	.729
	8	-.469	.303	.220	-1.433	.495
	9	-.253	.262	.405	-1.086	.580
2	1	-.385	.244	.213	-1.161	.392
	3	-.876*	.274	.049	-1.746	-.005
	4	-.216	.129	.193	-.626	.195
	5	-.499*	.105	.018	-.834	-.164
	6	-.043	.143	.784	-.496	.411
	7	-.637	.219	.062	-1.336	.061
	8	-.853*	.148	.010	-1.323	-.383

	9	-.638*	.175	.036	-1.195	-.081
3	1	.491	.312	.214	-.503	1.485
	2	.876*	.274	.049	.005	1.746
	4	.660*	.180	.035	.087	1.233
	5	.377	.293	.289	-.556	1.309
	6	.833*	.190	.022	.227	1.439
	7	.238*	.071	.044	.013	.464
	8	.023	.262	.937	-.812	.857
	9	.238	.105	.107	-.095	.570
4	1	-.169	.169	.391	-.707	.369
	2	.216	.129	.193	-.195	.626
	3	-.660*	.180	.035	-1.233	-.087
	5	-.283	.202	.255	-.926	.360
	6	.173	.164	.369	-.349	.695
	7	-.422	.153	.070	-.908	.064
	8	-.637*	.179	.038	-1.206	-.069
	9	-.422*	.103	.026	-.749	-.095
5	1	.114	.339	.758	-.966	1.195
	2	.499*	.105	.018	.164	.834
	3	-.377	.293	.289	-1.309	.556
	4	.283	.202	.255	-.360	.926
	6	.456*	.117	.030	.085	.828

	7	-.138	.233	.595	-.880	.603
	8	-.354	.117	.057	-.727	.019
	9	-.139	.208	.553	-.802	.525
6	1	-.342	.330	.377	-1.394	.710
	2	.043	.143	.784	-.411	.496
	3	-.833*	.190	.022	-1.439	-.227
	4	-.173	.164	.369	-.695	.349
	5	-.456*	.117	.030	-.828	-.085
	7	-.595*	.124	.017	-.990	-.199
	8	-.810*	.156	.014	-1.307	-.314
	9	-.595*	.114	.014	-.959	-.231
7	1	.253	.309	.473	-.729	1.235
	2	.637	.219	.062	-.061	1.336
	3	-.238*	.071	.044	-.464	-.013
	4	.422	.153	.070	-.064	.908
	5	.138	.233	.595	-.603	.880
	6	.595*	.124	.017	.199	.990
	8	-.216	.225	.409	-.933	.501
	9	.000	.054	.994	-.172	.171
8	1	.469	.303	.220	-.495	1.433
	2	.853*	.148	.010	.383	1.323
	3	-.023	.262	.937	-.857	.812

	4	.637*	.179	.038	.069	1.206
	5	.354	.117	.057	-.019	.727
	6	.810*	.156	.014	.314	1.307
	7	.216	.225	.409	-.501	.933
	9	.215	.205	.370	-.435	.866
9	1	.253	.262	.405	-.580	1.086
	2	.638*	.175	.036	.081	1.195
	3	-.238	.105	.107	-.570	.095
	4	.422*	.103	.026	.095	.749
	5	.139	.208	.553	-.525	.802
	6	.595*	.114	.014	.231	.959
	7	.000	.054	.994	-.171	.172
	8	-.215	.205	.370	-.866	.435

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 43

Variable 6

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	1.217325	.6160309	4
Day 10	.981650	.3272953	4
Day 11	1.635425	.1224826	4
Day 12	1.198675	.2978213	4
Day 13	1.454550	.3394518	4
Day 14	1.073350	.3402659	4
Day 15	1.2595825	.07146881	4
Day 16	1.471175	.3398639	4
Day 17	1.288400	.1327385	4

Appendix Table 44

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1.343	8	.168	1.701	.150	.362
	Greenhouse-Geisser	1.343	1.968	.682	1.701	.261	.362
	Huynh-Feldt	1.343	5.691	.236	1.701	.183	.362
	Lower-bound	1.343	1.000	1.343	1.701	.283	.362
Error(Time)	Sphericity Assumed	2.369	24	.099			
	Greenhouse-Geisser	2.369	5.905	.401			
	Huynh-Feldt	2.369	17.074	.139			
	Lower-bound	2.369	3.000	.790			

Appendix Table 45

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	.236	.374	.573	-.954	1.425
	3	-.418	.367	.337	-1.585	.748
	4	.019	.190	.928	-.587	.624
	5	-.237	.349	.545	-1.347	.872
	6	.144	.445	.768	-1.274	1.561
	7	-.042	.321	.904	-1.063	.979
	8	-.254	.305	.466	-1.223	.716
	9	-.071	.315	.836	-1.073	.931
2	1	-.236	.374	.573	-1.425	.954
	3	-.654*	.182	.037	-1.233	-.075
	4	-.217	.190	.337	-.823	.389
	5	-.473*	.098	.017	-.784	-.162
	6	-.092	.129	.527	-.501	.317
	7	-.278	.195	.249	-.898	.342
	8	-.490	.178	.071	-1.058	.079

	9	-.307	.184	.195	-.894	.280
3	1	.418	.367	.337	-.748	1.585
	2	.654*	.182	.037	.075	1.233
	4	.437	.208	.126	-.224	1.097
	5	.181	.193	.417	-.432	.794
	6	.562*	.147	.031	.096	1.029
	7	.376*	.052	.005	.212	.540
	8	.164	.199	.470	-.470	.798
	9	.347*	.093	.034	.050	.644
4	1	-.019	.190	.928	-.624	.587
	2	.217	.190	.337	-.389	.823
	3	-.437	.208	.126	-1.097	.224
	5	-.256	.162	.213	-.772	.260
	6	.125	.257	.660	-.694	.944
	7	-.061	.176	.752	-.622	.500
	8	-.272	.137	.141	-.708	.163
	9	-.090	.178	.649	-.656	.477
5	1	.237	.349	.545	-.872	1.347
	2	.473*	.098	.017	.162	.784
	3	-.181	.193	.417	-.794	.432
	4	.256	.162	.213	-.260	.772
	6	.381	.134	.066	-.046	.809

	7	.195	.203	.408	-.451	.841
	8	-.017	.091	.866	-.306	.273
	9	.166	.218	.502	-.528	.861
6	1	-.144	.445	.768	-1.561	1.274
	2	.092	.129	.527	-.317	.501
	3	-.562*	.147	.031	-1.029	-.096
	4	-.125	.257	.660	-.944	.694
	5	-.381	.134	.066	-.809	.046
	7	-.186	.188	.395	-.784	.412
	8	-.398	.187	.123	-.993	.198
	9	-.215	.209	.380	-.881	.451
7	1	.042	.321	.904	-.979	1.063
	2	.278	.195	.249	-.342	.898
	3	-.376*	.052	.005	-.540	-.212
	4	.061	.176	.752	-.500	.622
	5	-.195	.203	.408	-.841	.451
	6	.186	.188	.395	-.412	.784
	8	-.212	.198	.364	-.842	.419
	9	-.029	.063	.677	-.229	.171
8	1	.254	.305	.466	-.716	1.223
	2	.490	.178	.071	-.079	1.058
	3	-.164	.199	.470	-.798	.470

	4	.272	.137	.141	-.163	.708
	5	.017	.091	.866	-.273	.306
	6	.398	.187	.123	-.198	.993
	7	.212	.198	.364	-.419	.842
	9	.183	.230	.485	-.550	.916
9	1	.071	.315	.836	-.931	1.073
	2	.307	.184	.195	-.280	.894
	3	-.347*	.093	.034	-.644	-.050
	4	.090	.178	.649	-.477	.656
	5	-.166	.218	.502	-.861	.528
	6	.215	.209	.380	-.451	.881
	7	.029	.063	.677	-.171	.229
	8	-.183	.230	.485	-.916	.550

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix Table 46

Sensory evaluation

b. Appearance

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	5.000	.0000	4
Day 10	3.700	1.0132	4
Day 11	2.750000000000000	.245326690731329	4
Day 12	2.554166666666667	.759309506015779	4
Day 13	2.479166666666667	1.280868845744950	4
Day 14	1.750	2.0616	4
Day 15	1.450000000000000	1.676305461424021	4

Appendix Table 48

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	34.960	6	5.827	7.020	.001	.701
	Greenhouse-Geisser	34.960	1.483	23.578	7.020	.046	.701
	Huynh-Feldt	34.960	2.591	13.494	7.020	.015	.701
	Lower-bound	34.960	1.000	34.960	7.020	.077	.701
Error(Time)	Sphericity Assumed	14.941	18	.830			
	Greenhouse-Geisser	14.941	4.448	3.359			
	Huynh-Feldt	14.941	7.772	1.922			
	Lower-bound	14.941	3.000	4.980			

Table 49 Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	1.300	.507	.083	-.312	2.912
	3	2.250*	.123	.000	1.860	2.640
	4	2.446*	.380	.008	1.238	3.654
	5	2.521*	.640	.029	.483	4.559
	6	3.250	1.031	.051	-.030	6.530
	7	3.550*	.838	.024	.883	6.217
2	1	-1.300	.507	.083	-2.912	.312
	3	.950	.456	.129	-.501	2.401
	4	1.146	.615	.159	-.810	3.102
	5	1.221	.436	.068	-.168	2.610
	6	1.950	.896	.118	-.901	4.801
	7	2.250	.797	.067	-.288	4.788
3	1	-2.250*	.123	.000	-2.640	-1.860
	2	-.950	.456	.129	-2.401	.501
	4	.196	.419	.672	-1.136	1.528
	5	.271	.629	.696	-1.733	2.274

	6	1.000	1.058	.414	-2.367	4.367
	7	1.300	.870	.232	-1.468	4.068
4	1	-2.446*	.380	.008	-3.654	-1.238
	2	-1.146	.615	.159	-3.102	.810
	3	-.196	.419	.672	-1.528	1.136
	5	.075	.453	.879	-1.366	1.516
	6	.804	.740	.357	-1.551	3.159
	7	1.104	.515	.122	-.536	2.744
5	1	-2.521*	.640	.029	-4.559	-.483
	2	-1.221	.436	.068	-2.610	.168
	3	-.271	.629	.696	-2.274	1.733
	4	-.075	.453	.879	-1.516	1.366
	6	.729	.490	.233	-.830	2.288
	7	1.029	.385	.075	-.195	2.254
6	1	-3.250	1.031	.051	-6.530	.030
	2	-1.950	.896	.118	-4.801	.901
	3	-1.000	1.058	.414	-4.367	2.367
	4	-.804	.740	.357	-3.159	1.551
	5	-.729	.490	.233	-2.288	.830
	7	.300	.238	.297	-.458	1.058
7	1	-3.550*	.838	.024	-6.217	-.883
	2	-2.250	.797	.067	-4.788	.288

	3	-1.300	.870	.232	-4.068	1.468
	4	-1.104	.515	.122	-2.744	.536
	5	-1.029	.385	.075	-2.254	.195
	6	-.300	.238	.297	-1.058	.458

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 50 Color

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	5.00	.000	4
Day 10	3.700	1.0132	4
Day 11	2.625	.7500	4
Day 12	2.550	.6403	4
Day 13	2.50	1.291	4
Day 14	1.75	2.062	4
Day 15	1.450	1.6763	4

Table 51 Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	35.032	6	5.839	4.631	.005	.607
	Greenhouse-Geisser	35.032	1.832	19.119	4.631	.068	.607
	Huynh-Feldt	35.032	4.564	7.676	4.631	.012	.607
	Lower-bound	35.032	1.000	35.032	4.631	.120	.607
Error(Time)	Sphericity Assumed	22.696	18	1.261			
	Greenhouse-Geisser	22.696	5.497	4.129			
	Huynh-Feldt	22.696	13.692	1.658			
	Lower-bound	22.696	3.000	7.565			

Table 52 Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	1.300	.507	.083	-.312	2.912
	3	2.375*	.375	.008	1.182	3.568
	4	2.450*	.320	.005	1.431	3.469
	5	2.500*	.645	.030	.446	4.554
	6	3.250	1.031	.051	-.030	6.530
	7	3.550*	.838	.024	.883	6.217
2	1	-1.300	.507	.083	-2.912	.312
	3	1.075	.860	.300	-1.661	3.811
	4	1.150	.806	.249	-1.414	3.714
	5	1.200*	.200	.009	.564	1.836
	6	1.950	.896	.118	-.901	4.801
	7	2.250	.797	.067	-.288	4.788
3	1	-2.375*	.375	.008	-3.568	-1.182
	2	-1.075	.860	.300	-3.811	1.661
	4	.075	.149	.650	-.400	.550
	5	.125	1.008	.909	-3.082	3.332

	6	.875	1.197	.518	-2.934	4.684
	7	1.175	.990	.321	-1.976	4.326
4	1	-2.450*	.320	.005	-3.469	-1.431
	2	-1.150	.806	.249	-3.714	1.414
	3	-.075	.149	.650	-.550	.400
	5	.050	.932	.961	-2.917	3.017
	6	.800	1.098	.519	-2.696	4.296
	7	1.100	.881	.301	-1.705	3.905
5	1	-2.500*	.645	.030	-4.554	-.446
	2	-1.200*	.200	.009	-1.836	-.564
	3	-.125	1.008	.909	-3.332	3.082
	4	-.050	.932	.961	-3.017	2.917
	6	.750	.854	.444	-1.968	3.468
	7	1.050	.776	.269	-1.420	3.520
6	1	-3.250	1.031	.051	-6.530	.030
	2	-1.950	.896	.118	-4.801	.901
	3	-.875	1.197	.518	-4.684	2.934
	4	-.800	1.098	.519	-4.296	2.696
	5	-.750	.854	.444	-3.468	1.968
	7	.300	.238	.297	-.458	1.058
7	1	-3.550*	.838	.024	-6.217	-.883
	2	-2.250	.797	.067	-4.788	.288

	3	-1.175	.990	.321	-4.326	1.976
	4	-1.100	.881	.301	-3.905	1.705
	5	-1.050	.776	.269	-3.520	1.420
	6	-.300	.238	.297	-1.058	.458

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 53 Aroma

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	5.00	.000	4
Day 10	3.50	1.291	4
Day 11	3.25	.957	4
Day 12	2.475	.4992	4
Day 13	1.750	1.0408	4
Day 14	1.75	2.062	4
Day 15	1.450	1.6763	4

Table 55 Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	38.559	6	6.427	5.473	.002	.646
	Greenhouse-Geisser	38.559	1.515	25.447	5.473	.066	.646
	Huynh-Feldt	38.559	2.735	14.097	5.473	.025	.646
	Lower-bound	38.559	1.000	38.559	5.473	.101	.646
Error(Time)	Sphericity Assumed	21.138	18	1.174			
	Greenhouse-Geisser	21.138	4.546	4.650			
	Huynh-Feldt	21.138	8.206	2.576			
	Lower-bound	21.138	3.000	7.046			

Table 56 Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	1.500	.645	.103	-.554	3.554
	3	1.750*	.479	.035	.227	3.273
	4	2.525*	.250	.002	1.731	3.319
	5	3.250*	.520	.008	1.594	4.906
	6	3.250	1.031	.051	-.030	6.530
	7	3.550*	.838	.024	.883	6.217
2	1	-1.500	.645	.103	-3.554	.554
	3	.250	.479	.638	-1.273	1.773
	4	1.025	.777	.279	-1.448	3.498
	5	1.750*	.144	.001	1.291	2.209
	6	1.750	.854	.133	-.968	4.468
	7	2.050	.776	.078	-.420	4.520
3	1	-1.750*	.479	.035	-3.273	-.227
	2	-.250	.479	.638	-1.773	1.273
	4	.775	.470	.198	-.720	2.270
	5	1.500*	.456	.046	.047	2.953

	6	1.500	1.190	.297	-2.288	5.288
	7	1.800	1.068	.190	-1.598	5.198
4	1	-2.525*	.250	.002	-3.319	-1.731
	2	-1.025	.777	.279	-3.498	1.448
	3	-.775	.470	.198	-2.270	.720
	5	.725	.680	.364	-1.439	2.889
	6	.725	1.276	.610	-3.337	4.787
	7	1.025	1.085	.415	-2.428	4.478
5	1	-3.250*	.520	.008	-4.906	-1.594
	2	-1.750*	.144	.001	-2.209	-1.291
	3	-1.500*	.456	.046	-2.953	-.047
	4	-.725	.680	.364	-2.889	1.439
	6	.000	.791	1.000	-2.516	2.516
	7	.300	.682	.690	-1.870	2.470
6	1	-3.250	1.031	.051	-6.530	.030
	2	-1.750	.854	.133	-4.468	.968
	3	-1.500	1.190	.297	-5.288	2.288
	4	-.725	1.276	.610	-4.787	3.337
	5	.000	.791	1.000	-2.516	2.516
	7	.300	.238	.297	-.458	1.058
7	1	-3.550*	.838	.024	-6.217	-.883
	2	-2.050	.776	.078	-4.520	.420

	3	-1.800	1.068	.190	-5.198	1.598
	4	-1.025	1.085	.415	-4.478	2.428
	5	-.300	.682	.690	-2.470	1.870
	6	-.300	.238	.297	-1.058	.458

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 57 Texture

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	5.00	.000	4
Day 10	3.700	1.0132	4
Day 11	3.00	.816	4
Day 12	2.225	.5188	4
Day 13	1.625	1.3769	4
Day 14	1.75	2.062	4
Day 15	1.450	1.6763	4

Table 58 Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	40.892	6	6.815	8.182	.000	.732
	Greenhouse-Geisser	40.892	1.776	23.026	8.182	.025	.732
	Huynh-Feldt	40.892	4.169	9.808	8.182	.002	.732
	Lower-bound	40.892	1.000	40.892	8.182	.065	.732
Error(Time)	Sphericity Assumed	14.994	18	.833			
	Greenhouse-Geisser	14.994	5.328	2.814			
	Huynh-Feldt	14.994	12.508	1.199			
	Lower-bound	14.994	3.000	4.998			

Table 59 Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	1.300	.507	.083	-.312	2.912
	3	2.000*	.408	.016	.701	3.299
	4	2.775*	.259	.002	1.949	3.601
	5	3.375*	.688	.016	1.184	5.566
	6	3.250	1.031	.051	-.030	6.530
	7	3.550*	.838	.024	.883	6.217
2	1	-1.300	.507	.083	-2.912	.312
	3	.700	.507	.261	-.912	2.312
	4	1.475	.652	.109	-.601	3.551
	5	2.075*	.568	.035	.268	3.882
	6	1.950	.896	.118	-.901	4.801
	7	2.250	.797	.067	-.288	4.788
3	1	-2.000*	.408	.016	-3.299	-.701
	2	-.700	.507	.261	-2.312	.912
	4	.775	.484	.207	-.764	2.314
	5	1.375	.554	.089	-.389	3.139

	6	1.250	.750	.194	-1.137	3.637
	7	1.550	.608	.084	-.384	3.484
4	1	-2.775*	.259	.002	-3.601	-1.949
	2	-1.475	.652	.109	-3.551	.601
	3	-.775	.484	.207	-2.314	.764
	5	.600	.607	.396	-1.331	2.531
	6	.475	.945	.650	-2.531	3.481
	7	.775	.722	.361	-1.521	3.071
5	1	-3.375*	.688	.016	-5.566	-1.184
	2	-2.075*	.568	.035	-3.882	-.268
	3	-1.375	.554	.089	-3.139	.389
	4	-.600	.607	.396	-2.531	1.331
	6	-.125	.427	.789	-1.484	1.234
	7	.175	.284	.581	-.729	1.079
6	1	-3.250	1.031	.051	-6.530	.030
	2	-1.950	.896	.118	-4.801	.901
	3	-1.250	.750	.194	-3.637	1.137
	4	-.475	.945	.650	-3.481	2.531
	5	.125	.427	.789	-1.234	1.484
	7	.300	.238	.297	-.458	1.058
7	1	-3.550*	.838	.024	-6.217	-.883
	2	-2.250	.797	.067	-4.788	.288

	3	-1.550	.608	.084	-3.484	.384
	4	-.775	.722	.361	-3.071	1.521
	5	-.175	.284	.581	-1.079	.729
	6	-.300	.238	.297	-1.058	.458

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 60 Moisture

Descriptive Statistics

	Mean	Std. Deviation	N
Day 5	5.00	.000	4
Day 10	3.700	1.0132	4
Day 11	2.00	.000	4
Day 12	7.025	9.3275	4
Day 13	1.25	.957	4
Day 14	1.75	2.062	4
Day 15	.700	1.4000	4

Table 61 Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	126.319	6	21.053	1.486	.239	.331
	Greenhouse-Geisser	126.319	1.094	115.509	1.486	.310	.331
	Huynh-Feldt	126.319	1.245	101.424	1.486	.309	.331
	Lower-bound	126.319	1.000	126.319	1.486	.310	.331
Error(Time)	Sphericity Assumed	255.078	18	14.171			
	Greenhouse-Geisser	255.078	3.281	77.749			
	Huynh-Feldt	255.078	3.736	68.269			
	Lower-bound	255.078	3.000	85.026			

Table 62 Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	1.300	.507	.083	-.312	2.912
	3	3.000	.000	.	3.000	3.000
	4	-2.025	4.664	.693	-16.867	12.817
	5	3.750*	.479	.004	2.227	5.273
	6	3.250	1.031	.051	-.030	6.530
	7	4.300*	.700	.009	2.072	6.528
2	1	-1.300	.507	.083	-2.912	.312
	3	1.700*	.507	.044	.088	3.312
	4	-3.325	4.606	.523	-17.985	11.335
	5	2.450*	.486	.015	.905	3.995
	6	1.950	.896	.118	-.901	4.801
	7	3.000	1.036	.063	-.297	6.297
3	1	-3.000	.000	.	-3.000	-3.000
	2	-1.700*	.507	.044	-3.312	-.088
	4	-5.025	4.664	.360	-19.867	9.817
	5	.750	.479	.215	-.773	2.273

	6	.250	1.031	.824	-3.030	3.530
	7	1.300	.700	.160	-.928	3.528
4	1	2.025	4.664	.693	-12.817	16.867
	2	3.325	4.606	.523	-11.335	17.985
	3	5.025	4.664	.360	-9.817	19.867
	5	5.775	4.792	.315	-9.477	21.027
	6	5.275	5.350	.397	-11.752	22.302
	7	6.325	4.954	.292	-9.440	22.090
5	1	-3.750*	.479	.004	-5.273	-2.227
	2	-2.450*	.486	.015	-3.995	-.905
	3	-.750	.479	.215	-2.273	.773
	4	-5.775	4.792	.315	-21.027	9.477
	6	-.500	.645	.495	-2.554	1.554
	7	.550	.608	.432	-1.384	2.484
6	1	-3.250	1.031	.051	-6.530	.030
	2	-1.950	.896	.118	-4.801	.901
	3	-.250	1.031	.824	-3.530	3.030
	4	-5.275	5.350	.397	-22.302	11.752
	5	.500	.645	.495	-1.554	2.554
	7	1.050	.984	.364	-2.083	4.183
7	1	-4.300*	.700	.009	-6.528	-2.072
	2	-3.000	1.036	.063	-6.297	.297

	3	-1.300	.700	.160	-3.528	.928
	4	-6.325	4.954	.292	-22.090	9.440
	5	-.550	.608	.432	-2.484	1.384
	6	-1.050	.984	.364	-4.183	2.083

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).