Comparison of Carbohydrate, Photosynthetic, and Protein Data of Whole Foods and Processed Baby Foods

Team Bengals

Angela Barth
Tim Kolesar
Megan Sargent

LBS 145
TA: Susannah Cooper
Lab Wednesday 7-10PM

11/16/04

Abstract:

In our experiment we ran several tests on diluted solutions of processed baby food and fresh fruits and vegetables. During these experiments, we expect to discover whether or not there is a difference between the photosynthetic, protein, and carbohydrate content of homemade baby food and store-bought baby food. We used three different foods as our test groups: sweet potatoes, green beans, and bananas. After performing these tests, we should be able to determine whether there is a difference between the photosynthetic, enzyme, and carbohydrate content of the processed baby food and the homemade baby food. The tests that determined the carbohydrate content included Barfoed's test for determining a monosaccharide, Bial's test for identifying furanose rings, and the iodine test for the presence of starch. Then, we used the paper chromatography test to identify the pigments that are present, which should show us a difference between the photosynthetic content of each particular solution. And finally, we determined the enzyme makeup of the solutions by testing for PPO, or polyphenoloxidase, and we ran the Bradford Assay that shows the protein content of the fruits and vegetable. Our hypothesis was that there would be a significant difference when comparing certain properties between the homemade baby food and the processed baby food due mainly to processing mechanisms, but the results suggest there are no significant differences.

Introduction

The human body needs many different nutrients to grow and perform properly. During adolescence, the consumption of certain nutrients is even more essential to development. Such nutrients include carbohydrates, proteins, and fats (Anonymous, 2004). All natural foods will give a variety of these nutrients along with important vitamins and minerals. Processed food is claimed to be an equal and sometimes healthier substitute of fresh produce. Many international corporations are confident of the ingredients used to ensure fresh products that will not loose the initial taste or amount of nutrients (Anonymous, 2004).

There are many techniques used to preserve food such as canning, freezing, dehydration, refrigeration, and aseptic processing. All of these processes use some kind of additive to keep the product “fresh.” These additives include pigments, flavor-enhancers, and chemical compounds that sterilize the product to be preserved (Anonymous, 2004). Manufacturers can add antimicrobials and antioxidants to kill any bacterial growth that could occur and also reduce amino acid damage that can happen during processing. The addition of antioxidants can preserve proteins whereas natural food without these additions may have difficulty maintaining original nutrients due to natural food decay (Anonymous, 2004).

Concern over the use of synthetic additives has created a more urgent desire to create natural additives to improve shelf-life of products. Many different natural compounds are being tried to reduce microbial growth and delay oxidation reactions that cause browning. Most recently, experiments have been done on natural compounds such as hexanal, 2-(E)-hexenal, hexyl acetate and citrus oils. These four aroma compounds have been added to many different fresh food items from which a decrease in different types of microbial growth was observed (Lanciotti et al., 2004). The problem with natural and synthetic compound addition is still the principal argument of adding compounds to food that is not “naturally” there to begin with. When adding these compounds, the whole process is altering the chemical reactions that occur naturally within food products so that certain reactions occur later and sometimes not at all (Aguilera, 2004). The question of whether these new chemical additions will alter other factors as well becomes a prominent concern. Other factors to be concerned about are chemical bonding and cell mechanisms that have to do with important components such as carbohydrates, proteins, and photosynthesis.

Many parents are unclear on what type of food preparation is sufficient to give their families nutritious meals. For toddlers, some parents feel more comfortable giving their children “homemade” baby food which they produce themselves. This method entails parents to soften and mash food with nothing more added but water if necessary. Conversely, other parents are confident with the use of processed baby food for toddlers. There are many claims being made by scientists and parents alike stating that one method is arbitrarily better than the other (Anonymous, 2004). It is yet unclear which type of food preparation is the “best.” If one method is truly better than the other, there should be significant differences between the two.

In our lab experiment, we decided to compare processed baby food and fresh baby food by using six specific tests designed to analyze carbohydrates, proteins, and pigments of photosynthesis for each solution. Our hyphothesis was that there would be a significant difference in the results when comparing carbohydrates, pigments of photosynthesis and proteins to conclude that processing could be a factor that affects the specified areas being tested. The overall prediction was that homemade baby food products would contain a higher concentration of carbohydrates, proteins, and pigments of photosynthesis. Processed foods are made by manipulations and alterations that can sometimes change the overall structure and chemical components of food products (Aguilera, 2004). These alterations could then result in a loss or gain of certain concentrations when comparing fresh baby food and processed baby food. This type of result could then lead to the assumption that food products made without processing techniques could produce results that have a higher concentration of carbohydrates, proteins, and pigments of photosynthesis.

Our prediction for the carbohydrate portion of our experiment was that the processed baby food solution would have different results when comparing reducing sugars and starch due to processing techniques that could change the sugars conformation and properties pertaining to carbohydrates. Processing techniques such as temperature alterations and the addition of chemicals can affect different aspects of food structure and function (Aguilera, 2004). For the second part of our experiment dealing with photosynthesis, we predicted that the homemade baby food would have more prominent pigments of photosynthesis such as carotene and chlorophyll. A major aspect to consider pertaining to food engineering is plant characteristics like a cell wall and its durability when undergoing food processing. If a cell wall is more likely to break down in certain situations like food processing, the chance of losing certain nutrients and pigments contained within the cell is high (Aguilera, 2004). Our prediction was that processed baby food would have less pigments due to the many different devices used to process food which could lead to cell wall disruption. The prediction for the enzyme activity portion of our experiment was that the pH values of processed baby food and homemade baby food would be different, which would lead to a possible explanation that processing reactions could lower or increase pH values of food products. Certain processes such as intense heating or cooling and chemical additions that affect reaction rates can affect enzyme production and reactions. The purpose of some of these processes is to change enzyme concentrations and reactions to yield results that combat decay and microbial growth (Welti et al., 2004). The enzyme concentrations of certain products could then be altered along with pH values. These results could then be compared to homemade baby food which would ideally maintain its natural pH values.

We used green beans, bananas, and sweet potatoes as our objects of comparison. The first portion of our lab was devoted to carbohydrates. In this portion, we used three tests, Barfoed's, Bial's, and Iodine to examine characteristics pertaining to a carbohydrate. For the second portion of our lab we used paper chromatorgraphy as a way to compare pigments between our samples associated with photosynthesis. For the enzyme activity segment of our lab we used the Bradford Assay and PPO enzymes to test for protein content and the presence of PPO using catechol.

Methods

Materials

To create the samples for the carbohydrate and enzyme labs, the whole bananas, which were pealed, sweet potatoes that were pealed, and green beans were steamed and then pulverized using a mortar and pestle. These samples were purchased two to three days prior to the experiment at the local supermarket. 1% fructose was used as the positive control for all the sugar tests, with water as the negative control. 100 ml of distilled water was added to 5 grams of the pulverized whole green beans and sweet potatoes, and dissolved into two 250 ml beakers. 120 ml of distilled water was added to 5 grams of pulverized whole bananas, and dissolved in a 250 ml beaker. Each whole food and water solution was strained into 250 ml beakers with 4 layers of cheesecloth, and set aside. 10 grams each of the green bean and sweet potato baby foods (DelMonte Brand) were weighed and placed in separate 250 ml beakers. 100ml of distilled water was added to each beaker to create the solutions. Both were strained with four layers of cheesecloth. The same process was used with the banana baby food, with 120 ml of distilled water added to create the solution. To create the samples for the paper chromatography, the same amount of samples were created and filtered. This was added to 10 ml of phosphate buffer and centrifuged for 5 min and 5000 rpm. Once completed, the supernatant fluid was drained and 2 ml of ethanol was added. (Refer to the LBS 145 Laboratory Manual for further instructions)

Carbohydrate Analysis

For the carbohydrate lab, the Bial’s, Barfoed’s, and Iodine Tests were selected. 1 ml of the samples were pipetted into 18 glass test tubes, three replications for each of the six samples. Two test tubes for each test were then added, containing water and fructose to be used as controls. 3 ml of the reagent was used for the Barfoed's and Bial's Test. 35 ul of IKI solution was used for the iodine test. For the Bial's and Barfoed's, the reagent was added and heated in a boiling water bath. The iodine was added in a separate test and allowed to react. Results were recorded after the completion of each test. (Sayed et al., 2004)

Photosynthetic Analysis

Paper Chromatography was used to investigate information about the pigments in both whole and baby food products. Using the same samples of both whole and baby food forms of bananas, sweet potatoes and green beans. Spinach leaves were used as a positive control, with water as the negative control. To complete the test, a capillary tube loaded with chlorophyll acetone was dropped on a filter paper, 8 inches long, ½ inches wide, creating a drop on the paper. This was repeated until there were 40 dots on the filter paper, one dot a minute for 40 minutes. 3 ml of a petroleum ether:chloroform solution was added to a test tube, and the filter paper was then placed into this tube and sealed with a stopper. The chromatogram was then run upright at room temperature. Once the solvent had reached 1 cm to the top of the paper, it was removed and the location of the color bands were marked. Observations of the pigments were recorded. The Rf for each pigment was then calculated. (Sayed et al., 2004)

Enzyme/Protein Analysis

The PPO Test was use to determine if the enzyme PPO (polyphenoloxadase) was present in the six samples of whole and processed bananas, sweet potatoes, and green beans. Water was used as the negative control for both tests. In the beginning of the PPO test a litmus paper was applied to each treatment. The color change was then observed and recorded. Two drops of water were then added to sections of the food samples, along with a drop of .1% catechol. After one minute, observations were recorded. The Bradford Assay, used to discover protein concentrations, requires all six samples. 20 ul of each sample were put into 18 glass test tubes, along with water as a control. 30 ul water was added to each of the test tubes to bring the total fluid level of 50ul. 50 ul of NaOH was then added. Once the Bradford Reagent, which was made prior to the experiment, was diluted by four parts with water and filtered with filter paper, 3 ml of the solution was added to each test tube. This was left for 5 minutes and then a sample from each test tube was put into a cuvette and placed in a spectrophotometer. The absorbance was read at 595nm. A standard curve, created by running a very similar experiment using Bovine Serum Albumin was completed prior to performing the experiment on the six treatments. In this standard curve varying amounts of BSA, ddH20, Bradford Reagent and NaOH were added and allowed to stand for five-minute intervals. Once the interval was completed, the solution was put into a spectrophotometer at an absorbance of 595nm.The information gained from the Bovine Serum Albumin experiment was placed in a graph comparing protein amount (ug) and absorbance. This curve is then compared to the information found from the six treatments. The protein content for each food sample was then calculated. (Sayed et al., 2004)

Results

Carbohydrate Analysis:

In the carbohydrate analysis, the Barfoed's, Bial's, and Iodine Tests were completed. (Tables One, Two and Three). Barfoed's Test showed a clear red precipitate for both the baby food and whole green beans and bananas, and a slight red precipitate for the sweet potato in both the whole and baby food forms, showing a detectable amount of monosaccharides. (Table One) For the Bial's Test both whole and baby food forms of the bananas turned a muddy brown color, which shows a possible presence of hexose sugars. (Table two)The whole and baby food forms of sweet potato, along with the whole and baby food forms of green beans both turned an olive green color, indicating a presence of pentose-furanose sugars. For the Iodine test, every sample turned a blue-black color, with the exception of whole bananas. (Table Three) This indicates the presence of starch in these samples. Full results are summarized in tables one, two, and three.

Barfoed's Test: Used to test for the presence of monosaccharides.

Table 1: Three trials of each sample were completed to determine the presence of monosacchardes by Barfoed's Test. The monosaccharide will reduce the copper found in the solution and change to a red color. (LBS 145 Lab Manual)

	Trial One	**Trial Two**	**Trial Three**
Baby Food Banana	Red Precipitate Formed	Red Precipitate Formed	Red Precipitate Formed
Baby Food Green Bean	Red Precipitate Formed	Red Precipitate Formed	Red Precipitate Formed
Baby Food Sweet Potato	Slightly Red Precipitate Formed	Slightly Red Precipitate Formed	Slightly Red Precipitate Formed
Whole Food Banana	Abundant Red Precipitate Formed	Abundant Red Precipitate Formed	Abundant Red Precipitate Formed
Whole Food Green Bean	Abundant Red Precipitate Formed	Slight Red Precipitate Formed	Abundant Red Precipitate Formed
Whole Food Sweet Potato	Red Precipitate Formed	Red Precipitate Formed	Red Precipitate Formed
Water	No Red Precipitate	No Red Precipitate	No Red Precipitate
Fructose	Abundant Red Precipitate Formed	Abundant Red Precipitate Formed	Abundant Red Precipitate Formed

.

Bials Test: Used to test for the presence of furanose rings

Table 2: Three trials of each sample were completed to determine the presence of furanose ringed sugars by Bial's Test. If a sugar is a pentose-furanose, it will turn a olive green, a hexose: muddy brown, pyranose, no color change. (LBS 145 Lab Manual)

	Trial One	**Trial Two**	**Trial Three**
Baby Food Banana	Muddy Brown	Muddy Brown	Muddy Brown
Baby Food Green Bean	Olive Green	Olive Green	Olive Green
Baby Food Sweet Potato	Olive Green	Olive Green	Olive Green
Whole Food Banana	Muddy Brown	Muddy Brown	Muddy Brown
Whole Food Green Bean	Olive Green	Olive Green	Olive Green
Whole Food Sweet Potato	Olive Green	Olive Green	Olive Green
Water	No Color Change	No Color Change	No Color Change
Fructose	Olive Green	Olive Green	Olive Green

Iodine Test: Used to test for the presence of starch

Table 3: Three trials were completed to determine the presence of starch by the Iodine Test. If a starch is present, the IKI will turn the substance to a blue-black color. (LBS 145 Lab Manual)

	Trial One	**Trial Two**	**Trial Three**
Baby Food Banana	Black- Brown Color	Black- Brown Color	Black- Brown Color
Baby Food Green Bean	Black- Brown Color	Black- Brown Color	Black- Brown Color
Baby Food Sweet Potato	Black- Brown Color	Black- Brown Color	Black- Brown Color
Whole Food Banana	No Color Change	No Color Change	No Color Change
Whole Food Green Bean	Black- Brown Color	Black- Brown Color	Black- Brown Color
Whole Food Sweet Potato	Black- Brown Color	Black- Brown Color	Black- Brown Color
Water	Black- Brown Color	Black- Brown Color	Black- Brown Color
Fructose	Black- Brown Color	Black- Brown Color	Black- Brown Color

Photosynthesis:

Paper Chromatography

The paper chromatography was completed three times, with the first two using solutions described in the methods section. There were no colors detected on each of the strips for trials one and two, with the exception of the sweet potato in both the whole and baby food forms, which showed a very slight orange color. (Table Four) The Rf factor was not calculated for this since it was so small and not found on any other trial. For trial three, using a non-diluted form of the solutions, there was still no color change detected for any of the samples. Full results are summarized in table four.

Table 4: Three trials were completed by paper chromatography to determine the presence of the pigments chlorophyll A, chlorophyll B, carotene, and xanthophylls, using both diluted and undiluted solutions.

	Trial One	**Trial Two**	**Trial Three (Undiluted Solutions)**
Baby Food Banana	No Pigment Found	No Pigment Found	No Pigment Found
Baby Food Green Bean	No Pigment Found	No Pigment Found	No Pigment Found
Baby Food Sweet Potato	Slight Yellow Color Found On Bottom Of Strip	No Pigment Found	Slight Yellow Color Found On Bottom Of Strip
Whole Food Banana	No Pigment Found	No Pigment Found	No Pigment Found
Whole Food Green Bean	No Pigment Found	No Pigment Found	No Pigment Found
Whole Food Sweet Potato	Slight Yellow Color Found On Bottom Of Strip	No Pigment Found	Slight Yellow Color Found On Bottom Of Strip
Water	No Pigment Found	No Pigment Found	No Pigment Found
Spinach Leaves	Four Colors Detected	Four Colors Detected	Four Colors Detected

Enzyme/Protein Analysis:

In the enzyme analysis, both the PPO Test and Bradford Assay were completed. For PPO test, only the whole banana showed any color change when the catechol was added. When Ph strips were added, only the whole green bean indicated any color change, turning a slight green color or more basic. (Table Five) The Bradford Assay was completed by using three trials, and an average absorption was calculated. This absorption was compared to the standard curve created prior to the experiment with the baby and whole food samples. Once this was completed, the total protein content was calculated, showing that there was 0.0 grams of protein in each sample. Full results are summarized in Tables six and seven.

PPO Test:

Table 5: The PPO Test was completed to determine the presence of polyphenoloxidase. This was accomplished by applying Ph strips and catechol to each food sample.

	Ph Strips	**.1 % Catechol Test**
Baby Food Banana	No Color Change Ph =7	No Color Change
Baby Food Green Bean	No Color Change Ph =7	No Color Change
Baby Food Sweet Potato	No Color Change Ph =7	No Color Change
Whole Food Banana	No Color Change Ph =7	Some Color Change
Whole Food Green Bean	Green Color	No Color Change
Whole Food Sweet Potato	No Color Change Ph =7	No Color Change

Bradford Assay:

Table 6: Absorbencies of both Baby Food and Whole Food Samples

Sample	**Absorbance**
Baby Food Banana 1	.012
Baby Food Green Bean 1	.061
Baby Food Sweet Potato 1	.000
Whole Food Banana 1	.021
Whole Food Green Bean 1	.053
Whole Food Sweet Potato 1	.029
Water 1	.08
BSA 1	.496
Baby Food Banana 2	.042
Baby Food Green Bean 2	.098
Baby Food Sweet Potato 2	.000
Whole Food Banana 2	.056
Whole Food Green Bean 2	.030
Whole Food Sweet Potato 2	.020
Water	.081
BSA 2	.496

Baby Food Banana 3	.010
Baby Food Green Bean 3	.083
Baby Food Sweet Potato 3	.082
Whole Food Banana 3	.065
Whole Food Green Bean 3	.083
Whole Food Sweet Potato 3	.027
Water 3	.081
BSA 3	.496

Table 7: The Bradford Assay was completed to determine the protein content in each sample. This was accomplished by comparing the absorptions for the samples to a standard curve previously created using Bovine Serum Albumen.

Baby Food Banana	***Protein Content***
Baby Food Green Bean	0.0 Grams
Baby Food Sweet Potato	0.0 Grams
Whole Food Banana	0.0 Grams
Whole Food Green Bean	0.0 Grams
Whole Food Sweet Potato	0.0 Grams
Water	0.0 Grams
BSA	3.0 Grams

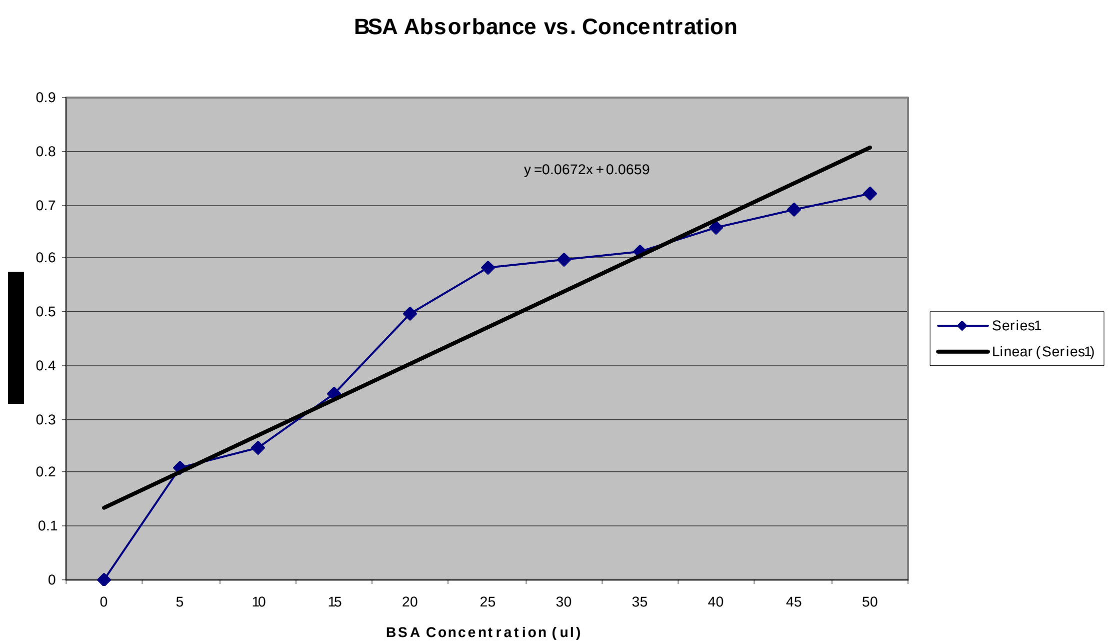

Figure 1: Standard Curve of BSA Concentration vs. Absorbance used to determine the protein content of each sample.

Discussion

In our experiment we were looking for differences between homemade baby food and processed baby food by examining the results of numerous tests for carbohydrates, pigments in photosynthesis, and the protein and enzyme activity. The specific tests used yield what type of carbohydrates are present, any pigment differences pertaining to photosynthesis, and enzyme activity dealing with certain enzymes like PPO and varying protein concentrations within the samples. Our hypothesis was that there would be a significant difference when comparing certain properties between the homemade baby food and the processed baby food due mainly to processing mechanisms, but the results suggest there are no significant differences.

For the first aspect of our lab dealing with carbohydrates, we used Barfoeds Test, Bial's Test, and the Iodine Test to test for the presence of reducing sugars, furanose rings, and starch. The original prediction for carbohydrates was that the perhaps the chemical compounds that make of carbohydrates could be altered during processing, hence creating a difference with homemade baby food. All of the samples, both whole and processed showed a red precipitate in the presence of the Barfoed reagent. This concludes that all the samples contained reducing sugars and our results showed no difference (for reducing sugars) between processed and whole baby food. The second test performed to test for what type of furanose rings each sample had was the Bial's Test. For green beans and sweet potatoes, an olive/green color was observed for all samples meaning that pentose furanose rings were present no matter the type of baby food solution. For the banana concentrations, there seemed to be no apparent difference between the two variables. All of the banana solutions produced a muddy brown color which indicated a hexose furanose. The last carbohydrate test used to compare the two variables was the Iodine Test. This test was used to see if there was a presence of starch in the solutions. The only sample to test negative for starch was the solutions made of fresh bananas. Both the whole baby food and processed baby food solutions produced a blue/black color in all of the samples indicating the presence of starch in all of the solutions except whole bananas. This suggests that during the processing of banana baby food, starch is added to the solution. This is known because of the lack of starch within the homemade banana baby food

The results of our three carbohydrate tests indicated that there was no difference between homemade baby food and processed baby food when comparing the presence of reducing sugars and the only difference for the presence of starch came from the lack of starch in fresh bananas. These types of qualitative experiments for carbohydrates yield only the presence of carbohydrates and a slight description of what kind. Yet, the tests used do not indicate the specific amount of reducing sugars or carbohydrates present in each sample. A better test would be to compare each variable by carbohydrate concentrations like for instance, which variable has a higher concentration of reducing sugars. It is reasonable to suspect that carbohydrate concentrations could differ after processing, yielding better comparative results whereas simply detecting the presence of certain carbohydrates due to observations apparently yield common results for both homemade baby food and processed.

The second aspect of our experiment dealt with photosynthesis. We were interested to know if pigments pertaining to photosynthesis such as carotene and chlorophyll would be present in each food and if homemade baby solutions versus processed baby food solutions would affect the results using paper chromatography. We predicted that the solutions made from processed baby food would produce different pigment pigments which could mean that the processed baby food contained differing types of pigments due to alterations from factors such as chemicals used in processing or temperature. The processed Rf factors would then be compared to the whole baby food Rf factors to see if there was any difference. The first trial used displayed no real results with the exception of two extremely light yellow spots near the bottom of the pigment strips for whole sweet potato and processed sweet potato. We felt these results were not very conclusive, so we decided to run the test two more times. The second and third trial produced no reaction or color. This lead us to the conclusion that the solutions made from homemade baby food and processed baby food contained no pigments pertaining to photosynthesis or the pigments levels are so low that they cannot be detected through the tests being used.

This test was inconclusive when comparing the difference between homemade baby food and processed baby food. A factor to consider is that photosynthesis of plants that produce food like sweet potatoes, green beans, and bananas occur within the leafy portions of the plant. The food created is simply a result of photosynthesis not the reaction site. A better experiment would be to test for certain pigments (not necessarily pigments of photosynthesis) known to be in whole food products and see if processed products contain the same or differing levels of pigmentation using paper chromatography.

The final testing of the experiment dealt with the activity of enzymes within our solutions through the use of the PPO test and the Bradford Assay. The PPO Test was used to determine the presence of polyphenoloxidase. This was accomplished by applying catechol to each food sample. It was believed that our solutions would contain very little PPO, and after a thorough analysis of our results it was determined that there was only slight amounts of PPO present in whole green beans and whole bananas. Yet, we believed that the preservatives added to processed baby food would contain PPO in order to enhance the color of the foods. Therefore our initial hypothesis was proven correct and there are only slight amounts of PPO present in our sample solutions of bananas and green beans. Then, we ran the Bradford assay in order to quantitatively determine how much of certain proteins that each of our solutions contains. A large difference between the protein content of our solutions was not expected prior to running the experiment, and the results of the experiment strongly supported our predictions. An examination of our results showed that relatively none of the proteins were tested for can be found within any of the fruits and vegetables that were being tested. Yet, it is important that one realizes that this does not by any means indicate that there are no proteins whatsoever present within these fruits and vegetables. In order to yield more results, one must test for different common proteins that are present in foods, and this will allow one to determine the makeup of the different solutions.

During the course of this entire experimentation, several possibilities for error may have played a role yielding the results that were recorded during our experiment. During the preparation of our solutions, we used cheesecloth to strain our solutions, in order to prevent large pieces of the material to collect within the diluted solutions. In straining our solutions, some of the carbohydrate, photosynthetic, and protein materials may have become separated from the solution. This would cause our results to give an inaccurate description of what is contained within our samples. Furthermore, our results may have been altered due to the dilution of the solutions. In diluting the solutions, the concentration of the certain enzymes, pigments, and molecules that we were testing for was drastically reduced and may have become so inconclusive that we didn't recognize their presence during the testing. It is also important to recognize that personal error is always a possibility when working with a group of scientists. It is easy to lose communication and accidentally mix up the results or solutions that are being recorded or tested in the experiment.

In conclusion, during carbohydrate testing we discovered that all of the solutions contained reducing sugars. It was also discovered that both solutions of sweet potatoes and green beans contained pentose furanose rings, while the solutions of bananas contained hexose furanose rings. Then, the iodine test showed that all of the solutions contained starch, except for the whole banana solutions. It was also determined that none of the foods we tested contain photosynthetic pigments. Then, we finally tested for enzyme activity and obtained no meaningful results besides the fact that none of the proteins we tested for are present in these foods and that there is only a hint of PPO within whole green beans and bananas. After a very thorough analysis, our initial hypothesis stating that there are significant differences between processed baby food and homemade baby food was proven incorrect from the results that were obtained.

Resources

1. Anonymous www.naturesgoodness.com/nutrition.asp 10/19/2004. Del Monte- Natures Goodness

2. Anonymous www.nfpa-food.org/upload/pdfs/ProcessedFoods.pdf. 9/8/2004. National Food Processors Association

3. Anonymous www.ifafitness.com/book1/i-protein.html 10/19/2004 International Fitness Association

4. Freeman, S. (2002). Biological Science. New Jersey: Prentice Hall Inc.

5. Lanciotti, R., Gianotti, A., Patrignani, F., Belletti, N., Guerzoni, ME., Gardini, F. 2004 Biological Science. Trends in Food Science & Technology 15 (3- 4): 201-208

6. Miguel-Aguilera, J. 2004 Journal of Food Engineering. Why Food Microstructure? 67 (1-2): 3-11

7. Sayed, M., Corby, R., Krha, M.. 2004. Summary of Carbohydrate Tests. LBS 145 Laboratory Manual. Lab 1: 4

8. Welti-Chanes, J., Vergara-Balderas, F., Bermudez-Aguirre, D. 2004 Journal of Food Engineering. Transport Phenomena in Food Engineering: Basic Concepts and Advantages 67 (1-2): 113-128