

Evaluation of the Aesthetic Differences Between Organically and Conventionally Grown Spinach Available in Market

By Oliver Slosser

Abstract There is a perceived difference for the consumer between organic and conventional food products available in markets, which can be attributed to many factors, including public attitudes, possible quality differences, or economics. Of these factors, for many consumers there is an assumed aesthetic difference between organic and conventional samples of the same product that weigh into their purchasing decision. Organic and conventional spinach from several sources was photographed digitally and the pictures were analyzed in order to apply a quality value for each sample. The quality values of the different forms of spinach were analyzed to see if there was a significant difference between the aesthetic qualities of different kinds of spinach. From the comparison of the photographs of the samples of spinach, there was no significant difference found between the damage and discoloration of the two types of spinach. Further analysis showed a possible difference between the damage and discoloration between spinach found in the farmers market and those taken from a market chain such as Andronico's, but as the sample set had not been designed to analyze this it can not be said to be a significant one. This lack of difference in the aesthetic qualities between organic and conventionally grown could be ascribed to a high requirement of aesthetic quality imposed by markets on growers and could be seen at the grower level. An interesting area for further research may be to sample straight from growers in the same area and see if there is any aesthetic difference at that level, as well as seeing a difference between chain markets and grower's markets.

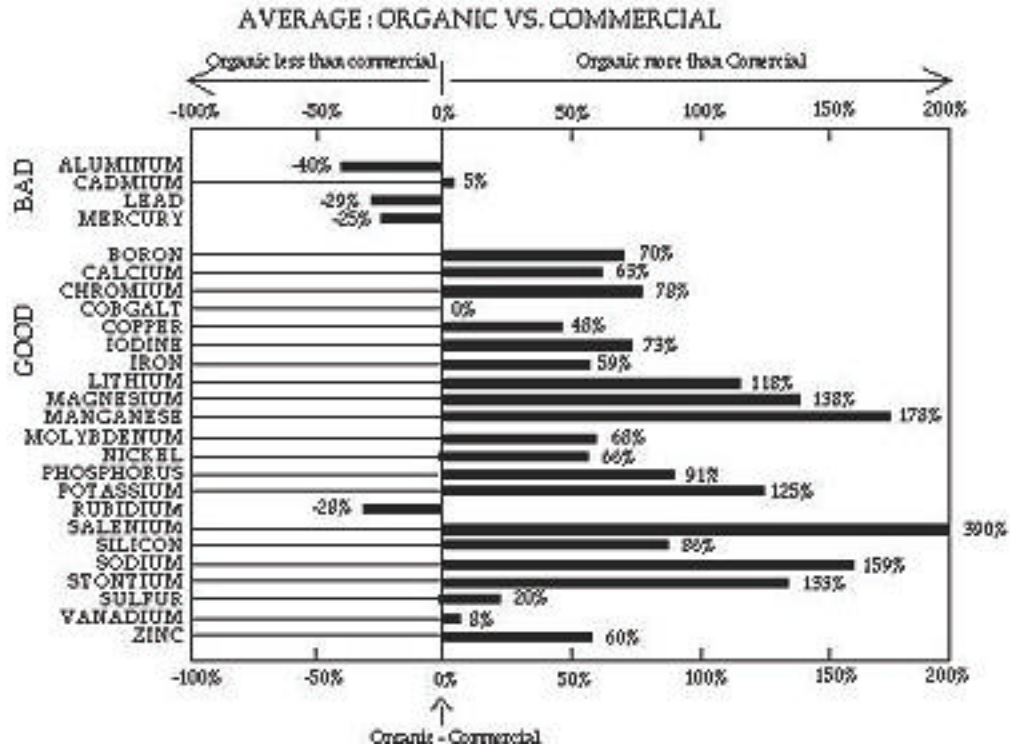
Introduction

The term organic used to categorize food products available to the consumer. The USDA defines organic as a labeling term that refers to a product produced in accordance with the USDA code that regulates organic food growth and handling (USDA) and limits use of man-made preservatives or chemicals. Organic food comes from crops and animals that are produced in a way that avoids the use of man-made fertilizers, pesticides, growth regulators and livestock feed additives (Institute of Food Science and Technology, 1999). This indicates that there are harmful elements used in commercial agriculture that are left out of organic foods offered to the consumers. The absence of these elements is part of the attraction of organic food to the consumer.

Consumer preference for organic food is attributed to social responsibility and environmental attitudes, and preference could be attributed to many other factors such as income, availability, and location. (Grunnert, 1995)(Antil, 1979) Regardless of the reason, there is a positive association with the term organic, one that is able to support higher prices in many instances for consumption and growth of organic foods.

The difference between organic and conventional products is defined in terms of production and the elements that go into the growth and handling of the products (Institute of Food Science and Technology, 1999). It is not quite as clear as to what the difference is in the values of the finished products. It is evident that some consumers are willing to pay a higher price for organic products. Though a certain amount of that willingness to pay derives from the added cost of production, it is reasonable to assume that they have a willingness to pay because of a perceived difference in the quality of the final product. There is an added value to organic food in the assumption that it is healthier than commercially grown food.

Other studies on the value of organic food have shown some difference in the quality of organic food, such as the elemental content differences between the two modes types:



Smith, Bob L. *Organic Foods vs Supermarket Foods: Element Levels. JOURNAL OF APPLIED NUTRITION, VOL 451, 1993*

Figure 1 indicates there is a difference in the elemental content of organic and commercially grown food. According to this study there are significantly higher levels of most elements in the organic food than in the commercial.

Regardless of all the varying factors that affect a consumer’s likelihood to purchase organic or conventional products, one very key factor that goes into any consumer’s purchase of a product is aesthetics. The visual quality and appearance of a product is a very important indicator of the value and quality of that product to the consumer.

Visual appearance can indicate to a consumer several attributes of a sample that influence their decision. The age of the sample, or time from harvest can be qualified

from the appearance of the spinach. Though it is impossible to tell exact time of harvest from the visual appearance of the spinach, certain age factors such as wilting and rotting. The appearance of any factor that makes the spinach look old and unappealing will cause the consumer to be less likely to purchase.

The difference in the growth conditions of organic and conventionally grown food suggests that there would be a difference in the visual appearance of the final product. Because the use of man-made fertilizers and pesticides is restricted under the guidelines for organic farming, the likelihood of pest infestation is increased in the case of organic products. The presence of pest damage, such as holes along the edges or in the body of the leaf, as well as presence of bugs on the spinach is factors that may influence a consumer's decision to purchase. These are only a few of the differences between organic and conventionally grown spinach that would suggest that there would be differences in the aesthetic qualities of the final product.

The last criterion of judging food is aesthetics and appearance. Once the consumer arrives at the store, his or her attitudes towards organics and education of organics are static. Assuming that their income is such that they are able to decide freely between organic and conventionally grown food, the final factor effecting choice is the appearance of the options they are considering. Because the methods of growth suggest there is a difference in the appearance between organic and conventionally grown food, and it is evident that it is an important indicator of quality to the consumer, it is important to investigate if there is a difference between the appearance of the two types of spinach in market.

Methods

To compare the aesthetic value of different samples of spinach, I created a criteria based on common sense factors assumed to go into consumer evaluations of market products. These factors are varied and the importance of each differs for each individual. I tried to identify as many negative indicators as possible, and assigned them equal value in affecting the degradation of a "perfect" quality value. These indicators included dirt content, evidence of yellowed flecks, discoloration due to water soaking, evidence of breakage, size of leaves and general appearance. These were all evaluated as significant

contributing influences to the aesthetic quality of the spinach and thus, factors that would affect the consumer visually.

Dirt content was evaluated by appearance alone. Though a quantitative amount of dirt may have been considered, the aesthetic nature of this assay made it unfavorable. Overall content does not reflect concentrated areas of dirt and debris and the affect upon the aesthetic quality of the sample. With that in mind, the dirt content and its' effect on the quality number of the sample was evaluated on a scale of 1 to 10 and comprised a 1/7 effect on the overall quality number. A score of 10 was assigned for a sample literally soaked in dirt or mud, and a score of 0 for a sample with no sign of any dirt or debris. These scores account for a 0- 10 point reduction in a "perfect score" of 70 for the sample, as does each of the other indicator.

Yellow flecking and general yellowing of the spinach was also evaluated as an indicator of quality. As for the dirt content, this was evaluated on a visual basis and was judged in term of frequency and prevalence. Leaf number and general frequency of yellowing on all the leaves of a sample was noted for each sample, and was quantified within a 0-10 range. This value of, from 0-10, was applied to the beginning score of 70 for the sample and decreased it accordingly.

Evidence of pest damage was evaluated as another of the 7 negative aesthetic attributes of a sample of spinach. Pest damage is seen as holes in the body, or around the edges, of the leaves of the sample. These holes are evidence of pest occurrence, and are noticeable degradation factors that occur during growth. The actual result of this factor on the quality of the spinach under investigation was not considered, only the affect on the appearance of the spinach to the consumer and their probability of buying a head of spinach with said defect. The frequency of pest damage was analyzed visually in relation to all samples looked at, and a value between 1-10 was assigned for the amount of pest damage seen. This value affected the overall, beginning number of 70 and in total, had a 1/7 effect on the final quality number.

Darkened leaves were evaluated as the fourth negative aesthetic attribute of the samples looked at. Darkening of leaves came in several forms. First, there was darkening of leaves that seemed to be caused by factors of growth. These instances showed darkened regions that in no way showed a changing in the original condition of

the leaf, but rather dark regions that had come about during growth. Secondly, there was darkening, or browning, that had occurred during the degradation of the original condition of the sample. The sources of this degradation could include water damage or rotting. This is a noticeable, and indicative indicator of quality. Like yellowing of the leaf, browning is a good indicator of time to market, and condition. Browned leaves were evaluated on the same basis, whether darkening due to growth, or browning indicating degradation. All darkening was evaluated on a 1-10 basis relative to all samples analyzed and comprised 1/7 of the affect overall upon the quality number assigned to the sample.

Breaks in the leaves or stems also comprised a negative attribute of the samples. Though this attribute was not an indicators of growth condition or degradation, it was an indicator of preparation and display. As this analysis was focused on the indicators to the consumer and factors that they would consider when selecting for purchase, anything that was visually noticeable and could be considered negative were evaluated and added into the criteria for assigning a quality number for each sample. Thus, breaks and tears in the leaves of the spinach were given a 1/7 value for the degradation of the overall quality number

Overall size of the spinach was considered as another of the seven factors affecting quality number. This was the one value that did not decrease the starting “perfect” number of 70 for each sample but rather added to it. The larger the size of the leaves and the bunch of spinach, the larger a number, ranging from 1-10 would be assigned to the sample. This method was meant to reflect a consumer’s increased likelihood of purchase for samples that exhibited larger size. The commonsense justification for this indicator was that larger size indicates increased value for the amount of money being spent and also could indicate the robustness and health of the plant. In other words, it was thought that the larger the leaf and bunch of the spinach, the more value the consumer would feel they were getting from their purchase. Both size of bunch and size of leaves were given 1-5 values and the combined number was applied to the overall quality number, not subtracted as with the other indicators

Wilting was the final indicator of quality assessed for the samples under investigation. Wilting was considered to be an indicator of travel conditions, time to market, and care of refrigeration conditions of the spinach. Increased amounts of stress

including heat, sunlight, and time are thought to be sources of wilting. Additionally, wilting is quite noticeable and only increases over time, and is a prominent attribute affecting a consumer's decision to buy. This criteria was judged on a 0-10 range and decreased a perfect number accordingly. This number comprised 1/7 of the overall quality number.

These indicators were recorded and applied to the overall quality number. This method was intended to create a number that reflected any damage and negative aspect of the sample.

The following steps were taken:

1. Samples were purchased in the store or at a supermarket.
1. The date, time of purchase and type of spinach were recorded.
1. Samples were then taken home and wrapped in paper towels to absorb any excess water from where it was stored in the market
1. Samples were stored in an igloo cooler with frozen blue ice to keep them cool while other samples were being photographed and recorded.
1. Samples were taken out of there paper towels and laid on white sheets of paper
1. Samples were then photographed in several forms. Pictures were taken of the sample as is, picture were taken of individual bunches of the sample and individual leaves.
1. Once photographed any indicator of damage was noted and photographed specifically so it would be evident during analysis
1. Notes were taken on indicators of damage, leaf size, relative amounts of leaves, color and statistics for the sample.
1. Once all the samples were photographed and recorded, they were assigned a quality number by determining and rating the individual indicators of damage present in each sample and applying those ratings to the overall quality number for the sample.
2. These quality numbers, as well as the ratings and frequency of each indicator were analyzed statistically to see if there was any significant difference between different forms of spinach, or spinach from different origins.

Samples were taken from several sources including supermarkets and farmer's markets. Samples were taken from Andronico's, Whole Foods, Safeway, Diablo Foods, Berkeley Farmer's Market, and Walnut Creek farmer's market. Samples were taken once a week over a four week period and analyzed directly after purchase. To ensure control for the experiment, samples were purchased by choosing the first bunches of spinach, those at the top of the pile. No initial examination was made of the samples before purchase.

Because the negative factors being assigned were based on my own judgment, it was important to ensure that there would be no bias as to the source of the sample being analyzed. Once purchased, the origin and mode of production of the samples were recorded, and then the sample was photographed and given a sample number. Once the photographs had been taken, the values of the negative factors were assigned using the photographs, with only numbers to identify them. Once all the values had been recorded, then the source and mode of production was reassigned to each sample.

Differences in the mean quality number for organic and conventional, as well as for supermarket and farmers market, were compared for significance using single factor ANOVA evaluation. The individual values for each of the negative attributes were analyzed using an ANOVA evaluation as well, to see if there were any significant differences in the data.

Results

The data collected was analyzed statistically using a single factor ANOVA test to determine if there was significant difference between the organic and conventional spinach quality number and negative attributes, and if there was a difference between farmer's market samples and conventionally grown samples negative attributes or quality numbers..

There were 33 samples collected and recorded for the seven negative aesthetic attributes and quality numbers, the data for which is shown below:

GRAPH 1: Average Quality

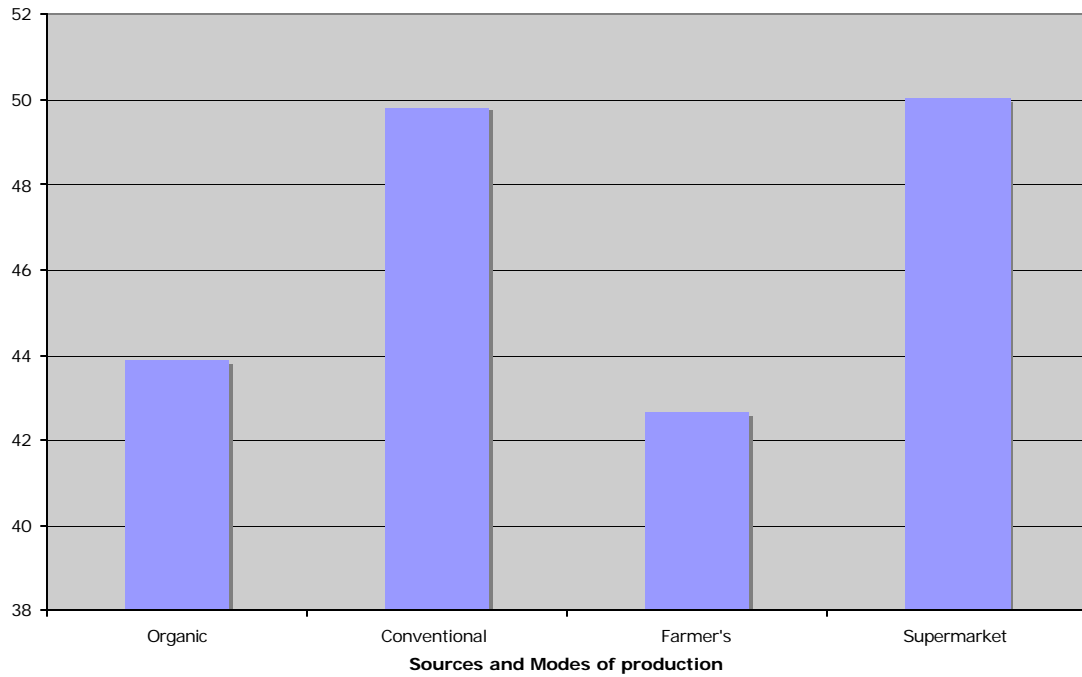


TABLE 1:

Table of Means and probability values for negative factors and quality number

	Organic (16 samples)	Conventional (17 samples)	(p-value)	Farmer's Market (14 samples)	Supermarket (19 samples)	(p-value)
Dirt	3.94	4.65	(.4426)	4.07	4.47	(.6542)
Yellow	4.375	2.47	(.0215)	4.86	2.32	(.0017)
Pest	3.375	2.12	(.0663)	3.64	2.05	(.0195)
Brown	2.94	2.41	(.4964)	2.64	2.68	(.958)
Breaks	2.81	3.23	(.3796)	3.14	2.95	(.6894)
Size	4.25	2.94	(.0011)	4.43	2.95	(.0002)
Wilting	4.44	2.35	(.0004)	4.5	2.52	(.001)
Quality Number	43.875	49.82	(.0048)	42.64	50.05	(.0003)

In the above table, average values for each factor and quality number are given, along with the p-values associated with their difference. The data shown in red are those that fall above a p-value threshold of $p=.05$, and those in blue are those that fall below. The data in blue can be said to be significant to a probability of 95%. Quality numbers are shown in black, even though the p-value associated with their averages and difference fall below the $p= .05$ confidence line. This is because for each of the four average quality numbers, more than one non-significantly different negative attribute constitutes the final number and thus it can not be said to be a completely significant result.

From this analysis of the data we can see what attributes have a significant differences. For both the comparison between organic and conventionally grown, as well as for farmer's market and supermarket sample, dirt content, browning, and breaks are all differences that have a probability far above the $p= .05$ threshold. All of these factor are additionally negative attributes having to do more with handling, preparation and delivery more than growth conditions. This suggests that the care put into handling and storing are not constant from market to market or from farm to farm, but vary widely between any source.

It is also evident that yellowing, size and wilting are all factors that are less prevalent in conventionally grown samples and samples bought from a supermarket over a farmer's market. This result my suggest that pesticides and preservatives used in conventional farming may play a role in deterring pests and preventing wilting and yellowing of the leaves. It may also suggest that the preparation and care of the spinach in the supermarket may also be a factor in preventing the occurrence of these negative factors.

TABLE 2:
Table of Means Comparing Sources and Modes of Production

	Organic	Conventional	(p-value)	Farmer's Market	Supermarket	(p-value)
Dirt	3.94	4.65	(.4426)	4.07	4.47	(.6542)
Yellow	4.375	2.47	(.0215)	4.86	2.32	(.0017)
Pest	3.375	2.12	(.0663)	3.64	2.05	(.0195)
Brown	2.94	2.41	(.4964)	2.64	2.68	(.958)
Breaks	2.81	3.23	(.3796)	3.14	2.95	(.6894)
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Wilting	4.44	2.35	(.0004)	4.5	2.52	(.001)
Quality Number	43.875	49.82	(.0048)	42.64	50.05	(.0003)

This second table shows all the factors where conventional growth was better than organic growth, and where supermarket purchased appeared better than farmers market (shown in plum). Additionally it shows where organic growth appeared better than conventional, and farmer's market purchases appeared better than supermarket purchases (shown in green). This analysis of the results highlights that for the most part, conventionally grown samples of spinach tend to have less negative attributes than do organically grown samples, and spinach purchased in a supermarket tends to appear better than spinach purchased in a supermarket.

Discussion

The results of this study are inherently open to interpretation. Though the methods and determinations of the aesthetic quality of the spinach samples were uniformly applied to each sample, the criteria for the assessment of the samples were created from common sense assumptions, and are therefore susceptible to human error. However, these common sense assessment criteria were considered to be criteria that many consumers would apply to products in market in order to make the decision to purchase. This common sense approach was turned into a quantitative evaluation of the

samples that was employed for each sample equally and thus is a uniform assessment of the sample and unbiased enough to determine any differences.

As can be seen from the results, it seems as though the null hypothesis is the most likely result of this investigation. The null hypothesis being that there is no significant difference between the visual qualities of organic versus conventional spinach. However, it can be said that there appears to be a significant difference between several of the negative attributes for the spinach under investigation, as was demonstrated in the above tables.

The fact that there seems to be a difference between the visual quality of spinach purchased in the farmer's market and spinach purchased in super markets is interesting as it may shed some light as to the factors that go into a consumers decision to shop at one source or the other. The average price of spinach at both sources was also different. On average, bunches of spinach purchased from several farms at two different farmer's markets were in the range of \$1.00-\$1.50. Spinach purchased in store usually ranged from \$1.50-\$2.00. Does this higher price reflect the difference in visual quality between the two, or rather reflect that spinach in the farmer's market comes directly from the farm and not through a supplier and thus the lack of more middlemen lead to a more wholesale price? Whatever the reason for the different price, it does seem evident that there is an aesthetic difference between the two and that farmer's market spinach is usually more damaged and less presentable than spinach that is found in supermarkets.

Another interesting consideration is if people go to farmer's market because to them there is an added value in spinach that looks more fresh and less processed? The presence of such things as dirt and small pest holes may to them make a sample more attractive and increase their willingness to buy.

As for my investigation as to differences between organic and non-organic spinach, it can be seen that there is some visual difference between the organic spinach versus conventional. It seems as though which store one goes to has a larger influence on the aesthetic quality of the spinach than does mode of production, though, as evidenced from Table 1 and the higher amount of significantly different factors . A future investigation might analyze samples that were grown together with only the modes of production being different and other conditions such as sunlight being constant for both.

Another possible avenue of inquiry could be to see if the different types of spinach degrade at faster rates under the same conditions of storage.

For the purposes of this investigation though, I think it can be seen that certain elements of a samples appearance have been shown to be different. Though I cannot say with confidence that spinach found in a supermarket always looks better than that found in a farmer's market, or that all conventionally grown spinach looks better than organically grown spinach, there do seem to be several attributes of the spinch's appearance that do seem to be determinate on how the spinach was grown and where it was sold from.

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