# Comparison of Juice Extractors: Enzymes

Michael Donaldson, Ph.D.

Hallelujah Acres Foundation
P.O. Box 2388
Shelby, NC 28151
(704) 481-1700
www.hacres.com

???

# A Comparison of Juice Extractors: Enzymes

Michael Donaldson, Ph.D., Hallelujah Acres Foundation

## Summary

Enzyme activity is a sensitive way to measure the amount of oxidation and degradation that occurs during carrot juice extraction. Two-step triturator and hydraulic press, twin gear, masticating, centrifugal basket, and centrifugal pulp-ejecting juicers were all included in this study. The two-step triturator/press produced juice with the highest enzyme activity, while centrifugal extraction produced juice with the lowest enzyme activity. The Green Life juicer did almost as well as the press-type extractors, while the Champion juicer was better than all of the centrifugal juicers. Of the 4 centrifugal juicers, the Omega produced the juice with the highest enzyme activity. Average amylase activity from the Norwalk juicer was 1.5-fold higher than the Omega, and 3-fold higher than in the Juiceman Jr. Average peroxidase activity from the People's Press was about 20% higher than the Norwalk or Green Life juicers, about 50% higher than the Omega, and about 2.5-fold higher than the Juiceman II or Juiceman Jr. The People's Press also extracted the most juice, 1.5-fold more than the Green Life juicer, making it the top choice for both quality and quantity of juice produced.

## Introduction

Which juice extractor is the best? That question has been asked many times. By what criteria would you judge one machine better than another? Some juicers may be easier and quicker to use and clean up, but our objective here is to answer this question scientifically, from a living foods perspective.

Living foods are about enzymes. Living foods have many beneficial properties, but what sets them apart are their active enzymes. Rather than choosing to analyze mineral and vitamin content of freshly extracted carrot juice, this study focuses on the enzymatic activity of the juice.

How much "life" is in the juice after extraction? Does one type of juicer deactivate more enzyme activity than another type? If so, how much more? Do certain juicers preserve the enzyme activity longer, making it possible to juice less frequently? Is it better to refrigerate or freeze juice overnight? Do organically produced carrots have more enzyme activity? Which juicer produces the most juice? These questions are all answered in this study.

## Materials and Methods

### *Supplies*

**Produce.** Bunny Luv carrots, purchased in a 50 lb bag, were used for most experiments. Organic Bunny Luv carrots, and a grocery store brand of carrots were also purchased for comparison to the large juicing carrots.

**Chemicals and equipment.** Reagents were all purchased from Sigma Chemical, Inc. (St. Louis, MO). Distilled, ozonated water was used for all buffer preparation. Oxygen was obtained from Kings Mountain Home Health Supply Co. (Kings Mountain, NC). A spectrophotometer (Spectronic 21-UVD) was rented from Spectronic Instruments (Rochester, NY) for analysis of the assays.

## *Juice extraction*

**Juicers.** Eight models of juicers were used in this study (see Table 1). Two step triturator and hydraulic press, twin gear, masticating, centrifugal basket, and centrifugal pulp-ejecting juicers were all included, representing all the major types of juice extractors currently on the market.

**Table 1.** Description of juice extractors.

| *Juicer* | *Type* | *Operation* | *RPM* |
|---|---|---|---|
| Norwalk, Mdl 260 | Grinder and hydraulic press | Batch | 3,600 |
| People's Press | Hydraulic press, with Champion as grinder | Batch | 1,725 |
| Green Life | Twin gear, low heat and speed | Continuous | 110 |
| Champion | Masticating | Continuous | 1,725 |
| Omega | Centrifugal basket, pulp retaining | Batch | 3,600 |
| Le Equip | Centrifugal, pulp ejecting | Continuous | 3,600 |
| Juiceman II | Centrifugal, pulp ejecting | Continuous | 6,300 |
| Juiceman Jr. | Centrifugal, pulp ejecting | Continuous | 3,600 |

**Juice preparation.** Carrots were peeled and rinsed in cold water. Large carrots were sliced into at least 3 lengthwise pieces. Approximately 10 pounds of carrots were prepared and mixed together for testing the 8 juicers. This ensured that one carrot would not unduly influence the results from a single juicer. 6-8 ounces of juice were prepared with each machine. Juice was stored in test tubes in ice water until assayed. For volume of extracted juice measurements, approximately 2 pounds of carrots were prepared per juice extractor. Pulp was removed from inside the Champion and Norwalk juicers for pressing to determine the maximum yield using the People's Press and the Norwalk press.

## *Enzymatic assays.*

**a -amylase.** Amylase was analyzed using a kit (Procedure No. 577) from Sigma Chemical, Inc. Briefly, 1 ml of reagent was mixed with 0.1 ml of sample. Readings were taken at 405 nm over 10 minutes with the spectrophotometer. The maximum slope was used to determine the activity, using 8.6 $mM^{-1}cm^{-1}$ as the extinction coefficient of p-nitrophenyl at 25ºC. 1 unit of amylase activity will release 0.8 µ mole of p-nitrophenyl phosphate from 1 µmole of substrate, 4,6-ethylidene-($G_7$)-p-nitrophenyl ($G_1$)-α -D-maltoheptaside per minute at 25ºC, pH 7.0.

**Peroxidase.** Peroxidase was analyzed using a procedure from the Worthington biochemical manual of enzyme assays (http://www.worthington-biochem.com/manual). Briefly, 25 µ l of 0.25% o-dianisidine, 20 µ l of 0.3% hydrogen peroxide, and 1.0 ml of 0.2

M potassium phosphate buffer, pH 7.0 were mixed in a 1 ml semi-micro cuvette. The potassium phosphate buffer was oxygenated for at least 10 minutes prior to use. 20 µl of carrot juice, or 50 µl of a 7-fold dilution of carrot juice were assayed. Readings were taken at 460 nm every 15 seconds for 3 minutes with the spectrophotometer. The maximum slope was used to determine peroxidase activity, using 11.3 $mM^{-1}cm^{-1}$ as the extinction coefficient of o-dianisidine. 1 unit of enzymatic activity will oxidize 1 µmole of o-dianisidine per minute at 25ºC, pH 7.0

## Results

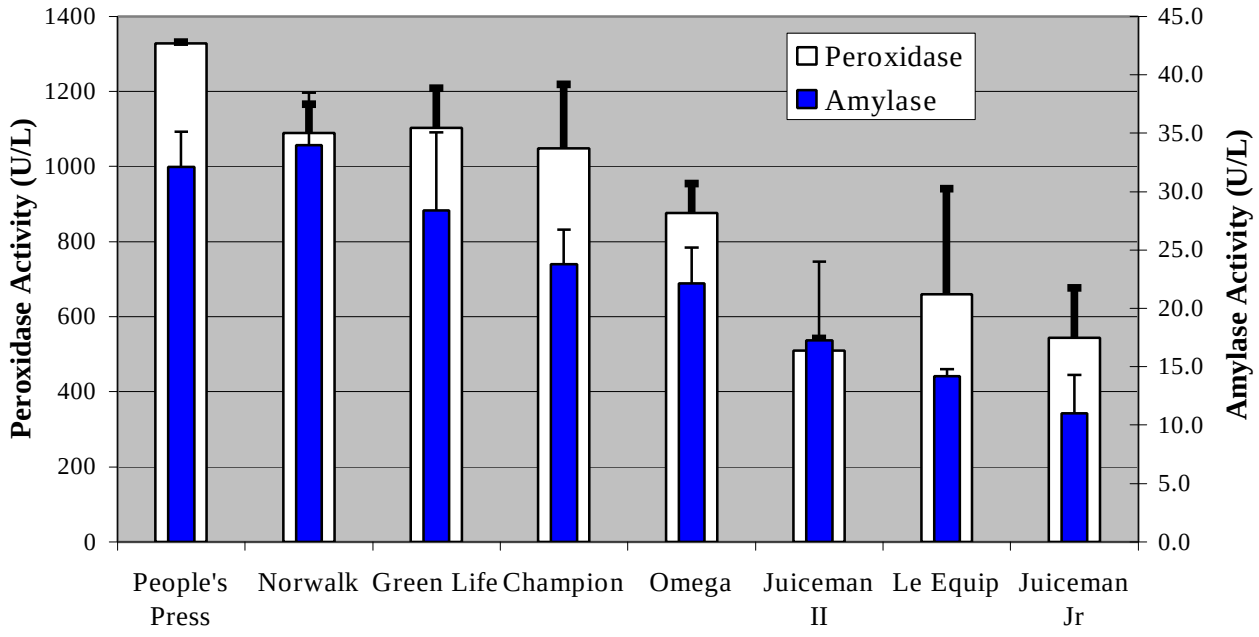
All juicer extractors had several parts to clean. The centrifugal juicers were the quickest and easiest to use, taking very little effort to feed the carrots into the machine. The Champion and Norwalk were fairly easy to feed carrots, while the Green Life took the most effort. The batch operation of the Omega, People's Press, and Norwalk make it more difficult to make a large volume of juice. Clean up takes almost the same amount of time for each juice extractor. The easiest machine to clean was the Norwalk, with its high quality, non-staining stainless steel. There were no fine mesh steel screens to clean with the People's Press or the Norwalk. However, both presses require the washing of a bag that was used for pressing. The two-step trituration/press process does take more effort overall.

### *Fresh juice enzyme activity*

Carrot juice was initially screened for activity of six enzymes. Levels of cellulase, tyrosine oxidase, glucose oxidase, and L-amino acid oxidase activities were very low in carrot juice. L-amino acid oxidase could only be detected in juice produced by the Green Life or Norwalk juicers, but not from the other machines. Of the six enzyme activities investigated, only peroxidase and amylase activities were high enough to be of practical use in evaluating fresh juice. Amylase is an enzyme that breaks starch down into the disaccharide maltose. Amylase is present in the saliva and begins the digestion of complex carbohydrates. Hydrogen peroxide is generated as a byproduct of aerobic metabolism; it is a reactive oxygen species which causes free radical damage and etabolic aging. By reducing $H_2O_2$ (hydrogen peroxide) to $H_2O$ (water) peroxidase helps protect our bodies from oxidative damage and keeps us feeling younger.

As shown in Figure 1, there were significant differences in peroxide and amylase activities in carrot juice produced by the eight machines. The overall trend was for the two step triturator/press to produce juice with the highest enzyme activity, while centrifugal extraction produced juice with the lowest enzyme activity. The Green Life juicer did almost as well as the press-type extractors, while the Champion juicer was better than all of the centrifugal juicers. Of the 4 centrifugal juicers, the Omega produced the juice with the highest enzyme activity. Average amylase activity from the Norwalk juicer was 1.5-fold higher than the Omega, and 3-fold higher than in the Juiceman Jr. Average peroxidase activity from the People's Press was about 20% higher than with the Norwalk or Green Life juicers, about 50% higher than with the Omega, and about 2.5-fold higher than the Juiceman II or Juiceman Jr. juice extractors.

**Figure 1.** Enzyme activity of fresh carrot juice produced in various juicers. Data is the average of 3 independent samples, with the standard deviation shown as error bars.




## *Enzyme activity of stored juice*

An important question for people is whether fresh juice can be stored. Claims have been made that the type of juicer will affect the storage-life of fresh juice. Samples of juice were stored in completely full test tubes (no foam), covered with plastic wrap at 4ºC. Separate tubes were removed and assayed for peroxidase and amylase activities after 1, 2 and 4 days. There was no overall trend in which type of juicer maintained enzyme activity in the juice the best. The Norwalk and People's Press were the only juicers in the top four juicers for both enzyme tests. Two of the centrifugal juicers did almost as well as the Norwalk press (see Table 2). In this particular test neither enzyme was degraded to a large extent after 4 days (30% loss for amylase, < 10% loss for peroxidase). The stability of peroxidase is well known; peroxidase has been used extensively in biochemical applications for this reason.

**Table 2a.** Stability of α -amylase in carrot juice stored in refrigerator.

| | *Activity, U/L* | *Percent of amylase measured at:* | | | | |
|---|---|---|---|---|---|---|
| *Juicer* | *Day 0* | *Day 1* | *Day 2* | *Day 4* | *Average* | *RANK* |
| Norwalk | 29.6 | 120% | 97% | 100% | 105.8% | 1 |
| Juiceman II | 23.6 | 117% | 91% | 109% | 105.6% | 2 |
| Juiceman Jr | 8.7 | 111% | 104% | 78% | 97.6% | 3 |
| Press | 34.2 | 100% | 85% | 75% | 86.6% | 4 |
| Omega | 23.8 | 95% | 77% | 76% | 82.5% | 5 |
| Champion | 27.2 | 100% | 62% | 86% | 82.4% | 6 |
| Le Equip | 13.5 | 92% | 70% | 70% | 77.5% | 7 |
| Green Life | 36.1 | 88% | 72% | 71% | 77.2% | 8 |

**Table 2b.** Stability of peroxidase in carrot juice stored in refrigerator.

| | *Activity, U/L* | *Percent of peroxidase measured at:* | | | |
|---|---|---|---|---|---|
| *Juicer* | *Day 0* | *Day 1* | *Day 2* | *Average* | *RANK* |
| Norwalk | 1,128 | 131% | 121% | 126% | 1 |
| Omega | 903 | 112% | 118% | 115% | 2 |
| Press | 1,331 | 110% | 117% | 114% | 3 |
| Green Life | 1,081 | 123% | 104% | 113% | 4 |
| Juiceman II | 524 | 99% | 121% | 110% | 5 |
| Champion | 1,235 | 95% | 119% | 107% | 6 |
| Le Equip | 541 | 111% | 96% | 103% | 7 |
| Juiceman Jr | 689 | 104% | 88% | 96% | 8 |

## *Frozen or fridge?*

Is it better to store juice in the refrigerator or the freezer? The peroxidase and amylase activities of carrot juice were assayed after storage overnight in a refrigerator or in the freezer. Our results show that freezing preserved the peroxidase activity better, while refrigeration preserved more amylase activity.

## *Organic?*

Carrot juice was prepared using the Champion juicer as a grinder and the People's Press from three batches of carrots—grocery store brand, Bunny Luv juicing carrots from a 50 lb bag, and organically produced Bunny Luv carrots, purchased from a grocery store. In Table 3 it shows that all three samples contained similar amounts of peroxidase activity. However, the organic carrots had twice the amount of amylase activity as the other two samples.

**Table 3.** Enzyme activity of carrots from 3 sources.

| *Source* | *Amylase Activity (U/L)* | *Peroxidase Activity (U/L)* |
|---|---|---|
| Grocery store | 36.4 | 1,351 |
| Bunny Luv | 32.0 | 1,115 |
| Organic | 62.6 | 1,018 |

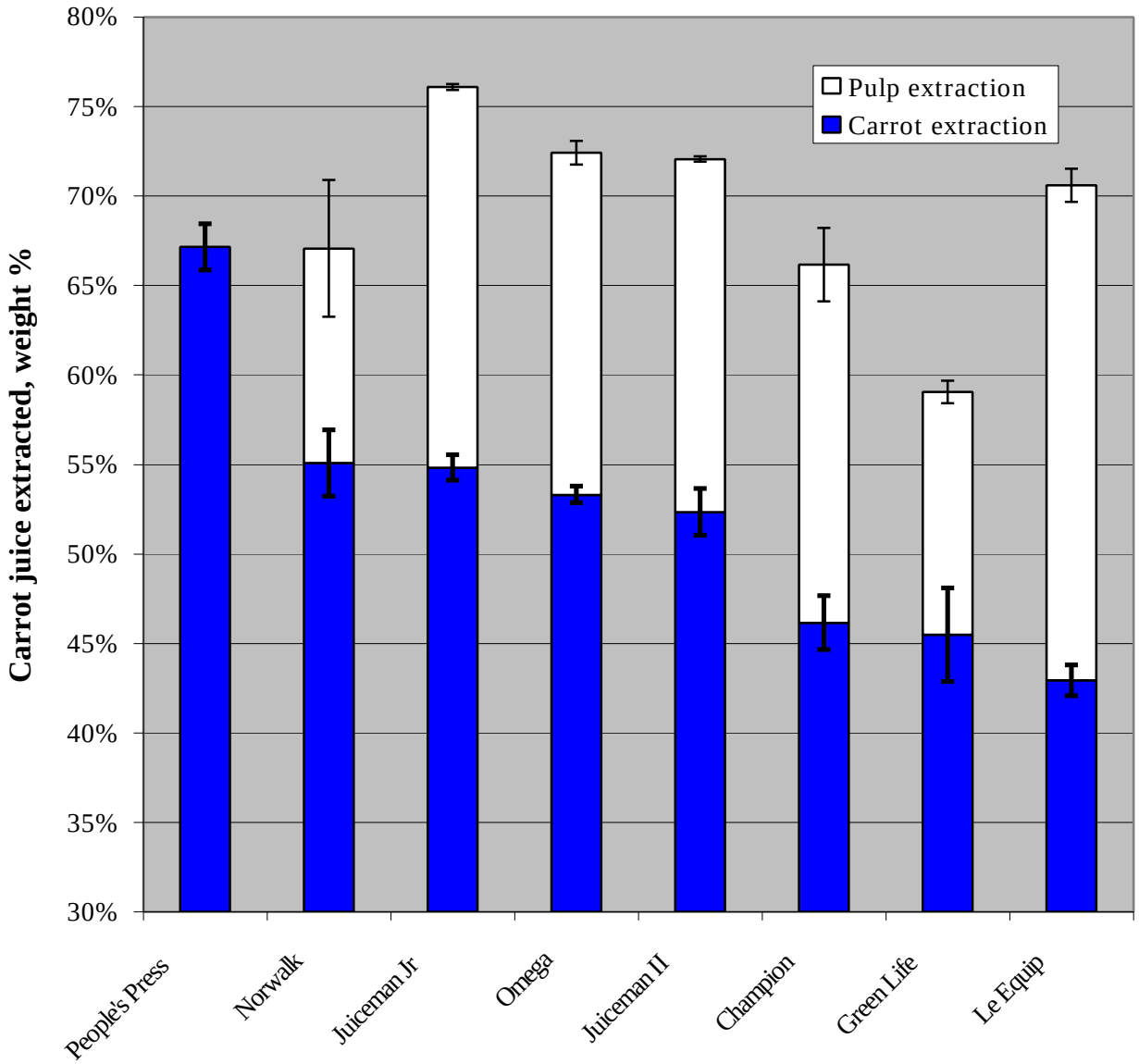
## *Volume*

Each of the eight juicers was tested for the amount of juice produced (see Figure 2). Also, the amount of juice that could be further extracted from the pulp using a hydraulic press was measured. The combination of the Champion triturator with the People's Press produced the most juice, converting about 0.67 g juice per gram of carrot (10.7 ounces per pound of carrots). The Juiceman Jr., Omega, and Juiceman II produced almost as much juice as the Norwalk press, about 0.54 g juice per gram of carrot (8.6 ounces per pound of carrots). The Champion and Green Life juicers gave very similar results, about 0.45 g juice per gram of carrot (7.2 ounces per pound of carrots).

When the pulp was extracted using the People's Press, 20-65% more juice was extracted. Only 20% more could be extracted after initially pressing with the Norwalk, due to its

efficient extraction. Only 30% more juice could be obtained from the Green Life juice extractor. The centrifugal juicers shred the carrot very finely and the masticating/triturator type juicers grind the pulp into a consistency close to apple butter, but the Green Life juicer produced pulp that was chunky and had a relatively large particle size. These large particles did not release their juice when subjected to high pressure. About 35-40% more juice was obtained from the centrifugal juicers. 65% more juice was obtained from the pulp from the Le Equip juicer. It appears to shred finely but not to extract the juice very efficiently.

**Figure 2.** Volume of carrot juice produced. Carrot extraction was done in the juicer listed. Pulp extraction was done with People's Press to determine the amount of extractable juice remaining in the pulp. All data is the average of 3 runs, with the standard deviation shown.



## Discussion

Enzymes are the catalysts that perform all of the reactions in our bodies. Life at the cellular level depends on enzymes. Our bodies make the enzymes necessary for life from the food that we eat. Proteins are digested and broken down into individual amino acids, which then are reassembled into the proteins that our bodies need.

The above paragraph is standard biochemical dogma. However, we know, both from experience and research that people who consume mostly enzyme-rich living foods enjoy good health. In fact, the Hallelujah diet and other similar mostly raw, living food diets have restored people to good health when they were sick. Many people experience even better health than before they became sick.

In addition to our experience, research has shown that whole proteins are absorbed through the gut lumen into the bloodstream. Systemic enzyme therapy with large oral doses of enzymes can be helpful in recovering from an acute injury, as many world-class athletes know and practice (see Lopez et al. [1]).

So then, do we need enzymes in our food? While not thoroughly proven, the information I have leads me to choose to eat foods that are enzymatically active. Any food processing that preserves (dehydration) or increases enzyme activity (such as fermentation and sprouting) would be beneficial, while cooking would be detrimental.

Several factors have been considered to be important in making good juice. Exposure to oxygen in the air, heat production, and foaming are all important factors to consider. Enzyme activity is a very good way to measure the amount of degradation that has occurred during juice extraction. It takes into account all the destructive effects of oxygen, heat, electromagnetic effects, and other factors. It tells you how much "life" is still in the juice.

Using enzyme content as our criteria, our results show that a two-step triturator/press is the best method to prepare fresh juice. This is not a surprise, since Max Gerson [2, p 217] and Norman Walker [3, p 14-15] both advocated this method of juice preparation for maximum benefit. The Green Life juicer is the next best extractor, with the Champion and Omega following. Finally, the pulp-ejecting centrifugal juice extractors are last. These juicers still produce enzyme-containing juice, but the enzyme loss is much greater with these centrifugal juicers. Max Gerson claimed that centrifugal juicers deactivated enzymes in the process of extracting juice. To our knowledge, this is the first quantitative investigation of this claim.

The results with the Norwalk and People's Press demonstrate that high-speed juice extraction does not necessarily deactivate enzymes. The speed of the motor or cutting blades does not reveal how much degradation will occur using a specific machine. The generation of heat by the high speed does not appear to cause any loss in enzymatic activity. This makes sense, since enzymes are heat stable at least to body temperature (37°C / ~99°F). No juicer heated the juice to this extent. Rather, it is the introduction of

air into the juice extraction process that is the more important question. Centrifugal juicers pull copious amounts of air through the machine during the juicing process.

The amount of foam produced during juicing is very critical. The Norwalk and People's Press generate very little foam with most of the bubbles being large in diameter. Other juicers produce more foam with much smaller bubbles. The more foam and smaller the bubbles, the greater the exposure to air and thus oxidation. There is a tremendous amount of surface area in foam for oxidation to take place. Any juicer that squeezes juice through a metal screen will cause substantial amounts of foam, resulting in greater losses of nutrients due to oxidation.

Our results did not show a strong trend in which type of juicer produced juice that stored well without loss of enzymatic activity. The Norwalk and People's Press performed well, but two centrifugal juicers also maintained amylase activity well. Perhaps other factors are more important in storing juice. The presence or absence of oxygen in the bottle may be the most critical factor. Enzymes which oxidize the nutrients in juice require oxygen for their activity. Without oxygen the nutrients are quite stable. The best storage methods would be to eliminate any air from the container by filling the container completely, to use a vacuum sealing container, or to flush the container with nitrogen to eliminate the oxygen. Reducing bacterial contamination by using clean jars and peeling and rinsing the carrots may be very helpful for storage of juice as well.

Claims have been made that the Green Life juice extractor produces juice that can be stored for longer periods of time compared to other juicers. It is possible that nutrients other than enzymes are preserved longer with the Green Life juicer. However, enzymes are generally at least as sensitive to oxidation as other nutrients so their activity should be a good indicator of the status of other nutrients as well.

In addition to producing enzyme rich juice, the People's Press, in combination with the Champion (used as a homogenizer), also extracted the most juice from the carrots (1.5 times as much as the Champion or Green Life), making it the best overall choice for juice quantity and quality. The centrifugal juicers produce almost as much juice as the Norwalk, but quality is much lower. For committed juicing an extractor that produces the highest quality juice is recommended. The People's Press, Norwalk, and Green Life all meet the standard of high quality juice. To get the most enzymes out of your carrots the best juicer is the combination of the Champion, used as a grinder, and the People's Press.

When considering the purchase of a juicer, several aspects need to be considered: quantity and quality of juice, ease of use, time required for juicing and clean-up, price, and health status of the user. Though the Norwalk or People's Press yield the best juice, a higher level of dedication is needed for this more involved process. For a beginner a good quality single step juicer may be the best overall choice.

## Acknowledgements

Thanks to Rev. George Malkmus, Sam Stoltzfus, and Dr. William Welles, D.C. for allowing the use of their juicers to make this study possible. Funding was provided by

the Hallelujah Acres Foundation, a non-profit National Heritage-administered foundation for research. For more information see http://www.hacres.com/html/foundation.html

## References


1. Lopez, DA, Williams, RM, Miehlke, M: Enzymes: The fountain of life. The Neville Press, Charleston, SC, 1994.
2. Gerson, M: A cancer therapy: results of fifty cases: a summary of 30 years clinical experimentation. Station Hill Press / Gerson Institute, Bonita, CA, 1958.
3. Walker, NW: Fresh vegetable and fruit juices. Norwalk Press, Prescott, AZ, 1970.


---

## The Hallelujah Acres Foundation: Who We Are

Rev. George Malkus established the Hallelujah Acres Foundation in 1997. Michael Donaldson was hired in 1998 as director of research. Our purpose is to conduct research to document the healing power of foods in the context of a Biblically-based vegetarian lifestyle.

Research projects completed include a vitamin $B_{12}$ screening, a fibromyalgia diet intervention study, and a diet survey. Current and future studies include an intervention study for heart attack victims, a retrospective cancer survival study, and a long-term tracking registry of Hallelujah vegetarians.

The Hallelujah Acres Foundation is a Donor Advised Fund under the administrative and tax umbrella of The National Heritage Foundation, which is a **501 (c)(3) tax-exempt organization**. All gifts to the Hallelujah Acres Foundation are tax deductible.

This information has been provided to you free of charge. If you have benefited from this information please pass it along to others who you think would also benefit. Also, please consider sending a donation to the Hallelujah Acres Foundation to help offset our costs in performing these tests and providing the juicer study results for you. By donating to the foundation you become a part of the spearhead that is bringing about a paradigm shift in the way we think about food, disease, sickness, and health. Contact Hallelujah Acres today for information about donating to the Hallelujah Acres Foundation.


Hallelujah Acres Foundation
P.O. Box 2388
Shelby, NC 28151
(704) 481-1700 http://www.hacres.com/html/foundation.html