Juicer and Nutrient Extractor Comparison

Revision 3
Report prepared for NuWave

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Introduction

NuWave's motto is "Live Well For Less." They have developed and successfully marketed induction cooktops, ceramic coated cookware and infrared ovens in an effort to provide high quality kitchen appliances at a reasonable cost, with proven benefits to indeed help people prepare higher quality food more quickly and easily.

In line with their mission, the engineers at NuWave have developed a vertical single-auger slow revolution juicer. The advantages of juicing are well known to this author. Consuming fresh vegetable and fruit juice is a core part of the Hallelujah Diet. Fresh vegetable and fruit juices are more easily and completely digested than the same amount of food simply chewed and swallowed. Further, the amount of vegetables that can be consumed is much higher when drinking the juice of the vegetables, compared to eating the whole vegetables. While there are many benefits to eating the fiber of raw vegetables, there are times when a higher intake of vegetables is very beneficial for one's health. A person can easily drink the juice from 2, 4, or even 8 pounds of produce in a day, but eating this much produce can be a challenge for many people. You can get almost all of the benefits of the produce by drinking the juice of the vegetables. Indeed, fresh vegetable juice has been the key to many people regaining their health.

Another advantage of juicing is that chemical residue sprayed onto fruits and vegetables tends to stick to the fiber of the produce during processing. So, most of the fungicides and pesticides end up in the pulp, not in the fresh vegetable juice. This is yet another way of getting clean food in spite of having a polluted environment around us. Using organic produce all of the time is ideal, but sometimes that is not available, or is cost prohibitive. Your juicer can help you out.

There is no lack of juicers on the market today. Everything from inexpensive high-speed, spinning-basket, pulp-expelling centrifugal juicers, to masticating medium-speed Champion juicer, to the low speed vertical and horizontal single auger juicers, to the twin gear low speed juicers, and even to the 2-step grind and press juicer like the Norwalk. People have many options to choose from. There are many factors to consider when purchasing a juicer, including ease of use and cleanup, ability to handle different kinds of produce as well as nuts, seeds, and frozen bananas, quantity of juice produced, and the quality of the juice from each machine. A high quality juicer can cost more than $400. The cost of these juicers sometimes causes consumers to compromise on quality and buy a juicer they think they can afford and hope it will work well. If a high quality juicer was available that provided the benefits and build quality of more expensive juicers, but without the expensive price tag (live well for less), more people might incorporate juicing into their health routine.

This report focuses on the quality aspect of the juices made from several different appliances. Quantitative yields were measured as well. In particular, the enzyme activity levels of six different endogenous enzymes are measured, as well as vitamin C concentrations of orange juice.

Why measure enzymes? Briefly, the endogenous enzymes of plants are heat- and oxidation-sensitive biomarkers. If raw produce is not subjected to heat above about 110°F for any extended time, and not exposed to oxygen, it is expected to have all of the enzymatic activity that was present in the initial, raw state of the produce. Any amount of heat and oxygen exposure will denature the sensitive enzymes in a plant. These enzymes, then, are a sensitive method for determining the degree to which a food processing method preserves the raw state of a food. This method of testing has been successfully used to test dehydrated barley grass juice powders and dehydrated whole leaf barley grass powders, as well as almonds and almond nut butters, with results posted on www.rawfoodlab.org. It has also been used to determining the effects of blending versus juicing fresh produce and to compare a series of different juicers.

Vitamin C is a sensitive antioxidant that is easily oxidized by heat and rapid stirring, as in a blender. While it can be difficult to measure low amounts of vitamin C naturally occurring in some fruits and vegetables, oranges are a rich source of vitamin C, making them a key food for measuring degradation of vitamin C.

Materials & Methods

Produce. Oranges, carrots and kale were purchased from Cash & Carry, a local restaurant supply store. Apples, cameo variety, were obtained from a local orchardist. Buffer salts, colorimetric enzyme substrates, and other chemicals were purchased from Sigma-Aldrich Chemical Company (St. Louis, MO).

Juicers and blenders. Appliances used for testing were supplied by NuWave. The blenders that were tested are the Ninja Blender, the Vitamix blender (two speed version), and the Nutribullet Rx. The juicer reported on here is the NuWave slow juicer prototype. This vertical auger juicer has a single auger that turns 48 rpm. The slower speeds reduce oxidation due to rapid mixing with air.

Samples. One pound of kale was processed in the juicer, and 8 ounces (226 g) were processed in each blender. Distilled water was added to the blenders to facilitate blending and to produce a drink that could be consumed without being too thick, due to not removing the fiber. For kale drink from the blenders 24 ounces (680 g) of water were added to the 8 ounces of kale. When only 8 ounces of water were added the consistency of the final product was too thick and was very difficult to blend. The whole mix became very warm during the processing, so a greater amount of water was used, which was much more satisfactory.

Other than the kale, enough produce was processed through the NuWave slow juicer to produce 16 oz (454 g) of juice. Depending on the yields, this amount varied by the produce. All produce was weighed before juicing or blending, and the juice was weighed after processing. Pulp in the juice was strained out with a sieve.

For the blenders, a mix of 50/50 (by weight) of produce and distilled water was used, except as noted above for kale. For the Ninja blender and Vitamix blender one pound of produce (453.6±0.1g) was mixed with one pound of distilled water. For the Nutribullet Rx it was filled up to the “max” fill line (42.5 oz wt) with 21.25 oz wt (602 g) of produce and 21.25 oz wt (602 g) of

distilled water. This ensured complete blending as shown in the instruction material for the Nutribullet Rx.

Length of time for blending. Special care was taken with the blenders to attempt to get a full blend so as to produce a final drink that had a smooth mouth feel with complete blending of the fiber. Initial experiments with carrots showed that the Nutribullet's 1 minute cycle did not yield a smooth carrot drink. After a second one-minute cycle the drink was acceptable, though it was already warm. One minute of blending on high speed in the Vitamix yielded a drink that was smoother than the Nutribullet's drink after 2 minutes. One more minute was used to get a completely smooth carrot drink in the Vitamix. After 3 minutes on speed "3" (the maximum speed) in the Ninja blender there was still lots of pulp and could not be drunk. After 2 more minutes the product was better, though still not as smooth as either of the other two products. It is not clear that more blending would render a smoother product, so 5 minutes was chosen as a processing time for the Ninja. Consumers would not likely try to blend ingredients much longer than 5 minutes.

So, the Ninja blender was run for 5 minutes to process drinks, and the Nutribullet Rx and Vitamix were run for 2 minutes each for all samples.

Assays. Six enzymatic assays were performed on each sample of juice. The six enzymes are acid phosphatase, alpha mannosidase, N-acetyl beta-D-glucosaminidase, leucine amino peptidase, beta-glucosidase and beta-galactosidase. Assays were performed in 96-well plates at 37°C in a water bath. Molar extinction coefficients were determined from the slopes of the appropriate free colorimetric species being tested (4-nitrophenol for acid phosphatase, alpha mannosidase, N-acetyl beta-D-glucosaminidase, and beta-glucosidase, 2-nitrophenol for beta-galactosidase, and p-nitroanilide for leucine amino peptidase.) Detailed assay methods are available in another document. Briefly, 200 µl of buffer (0.3M acetate buffer, pH 5.0 for acid phosphatase, alpha mannosidase, and N-acetyl beta-D-glucosaminidase, and Z buffer (a phosphate-based buffer, pH 7.60) for leucine amino peptidase, beta-glucosidase and beta-galactosidase) was added to each well of a polypropylene assay plate. Distilled water was added to wells for substrate control and sample control in place of substrate and samples. Samples, usually 20 µl, were added to the appropriate wells, 6 wells for control and 6 wells for active enzyme testing per sample. In this manner 7 samples could be tested per 96-well plate. Acid phosphatase assay required a smaller amount of sample for kale, 5 µl rather than 20 µl, because of the rapid reaction rate of this assay. After warming the reaction plates to 37°C in a waterbath, 20 µl of substrate were added to the appropriate wells. For assays 15 minutes or longer, the plates were covered with full-plate flexible rubber covers designed for PCR work (Perkin Elmer). Each well was individually covered to prevent evaporation during the assay. After the appropriate amount of time, empirically determined, ranging from 2 to 60 minutes, in order to get enough change in absorption without going beyond about 2.0 absorption units, the assay was stopped with the addition of 100 µl of 1.0M sodium carbonate, raising the pH up to about 12, at which enzyme activity ceased. Samples were spun for 1 minute at 1,000Xg in a tabletop centrifuge (Jouan Centrifuge CR422). Samples, without debris, were pipetted into a clear assay plate. Usually 200 µl was used as the volume, but for kale samples 100 µl was used, as there was a very high background level of yellow (carotenoids) from the pigments in these leafy greens. The 96-well plate was read in a Bio-Tek PowerWave X Select plate reader, using KC-4 software for evaluation of the measurements and calculations of the enzyme activities. Plates were corrected for background absorption of empty, blank plates. Outliers were scanned for by examining %CV values for each sample. If a %CV value was above about 2 or 3% for a sample, it was examined for single well outliers. When a single well was clearly different from the other 5 wells, it was excluded from the measurements. If 2 wells

appeared to be outliers, but had similar absorption, there were generally left in the calculation, assuming that this was normal variation. The %CV values for each sample were generally less than 3% when outliers were excluded.

Error Analysis. Each sample and juice combination was replicated a total of three times. A few sample data points did not agree by a large margin with the other two data points. This showed up as a very large %CV in the analysis, usually greater than 15%. Such data points were excluded from calculations. Between-sample variation was quite a bit greater than within sample-variation in the assay. CV values for the replicate samples for carrots ranged from 5 to 10%, for apples from 11 to 60%, for oranges from 14 to 25%, and for kale from 40 to 50% for blenders, but only 16 to 21% for juicers. To test within-sample variation 6 replicates of a single sample were analyzed, which yielded CV values of 1 to 7%, with an average of 4.7% for all 6 assays. So, while the assay method is quite accurate, there is a great deal of variation in actual enzyme activities between different samples of produce analyzed on different days.

All four types of produce were compared with each sample being replicated a total of 3 times each. Results of enzyme testing are presented in normalized enzyme units for summary charts. To compare one enzyme activity with others, or to find averages, each activity was normalized to the highest activity in the set. This enables the calculation of an average enzyme activity, given as a percentage of the highest reading obtained. So, quantitative information is not lost, as done with ranking, and each enzyme activity has equal weight because of normalization.

Statistical tests were performed to compare outcomes of combinations of certain juicers and enzyme activity. The student t-test, with 2 tails, was used for these comparisons. A probability less than 0.05 was considered statistically significant, taking into account multiple comparisons with the Bonferroni correction.

Graphs are presented with standard deviations of the sample shown as error bars. The standard deviation, though larger than the standard error of the mean, may be more appropriate, as it shows the expected variation in a population of samples for each sample, rather than just the expected variation in the mean of the population.

Results & Discussion

Enzyme Activity in NuWave juicer compared to Pasteurized Juice. Nationwide availability of flash pasteurized juices has lead to an increase in overall consumption of vegetable juice. These pasteurized juices have a much longer shelf life than homemade juice. However, our testing showed that these pasteurized juicers are missing a key component—the vitality of the juice. Virtually all enzyme activity is zero in pasteurized carrot juice, orange juice, apple juice, and a blend of fruit / kale juice, as shown in Figure 1. The benefits that come from consuming fresh vegetable juices cannot be obtained from these products.

Enzyme Activity in Kale. Kale is a very fibrous leafy green vegetable. It isn't particularly juicy or succulent vegetable. As such, it is quite a challenge to efficiently extract juice and nutrients from kale. For the blenders a 25:75 ratio of kale:water was used to allow it to blend well without excessive heat, and to thoroughly reduce the size of the fibrous matter of the kale. Because of this necessary dilution, it is not possible to get as much enzyme activity into a serving of beverage from a blender compared to the NuWave slow juicer, as shown in Figure 2.

Figure 1. NuWave Slow Juicer Compared to Pasteurized Juices

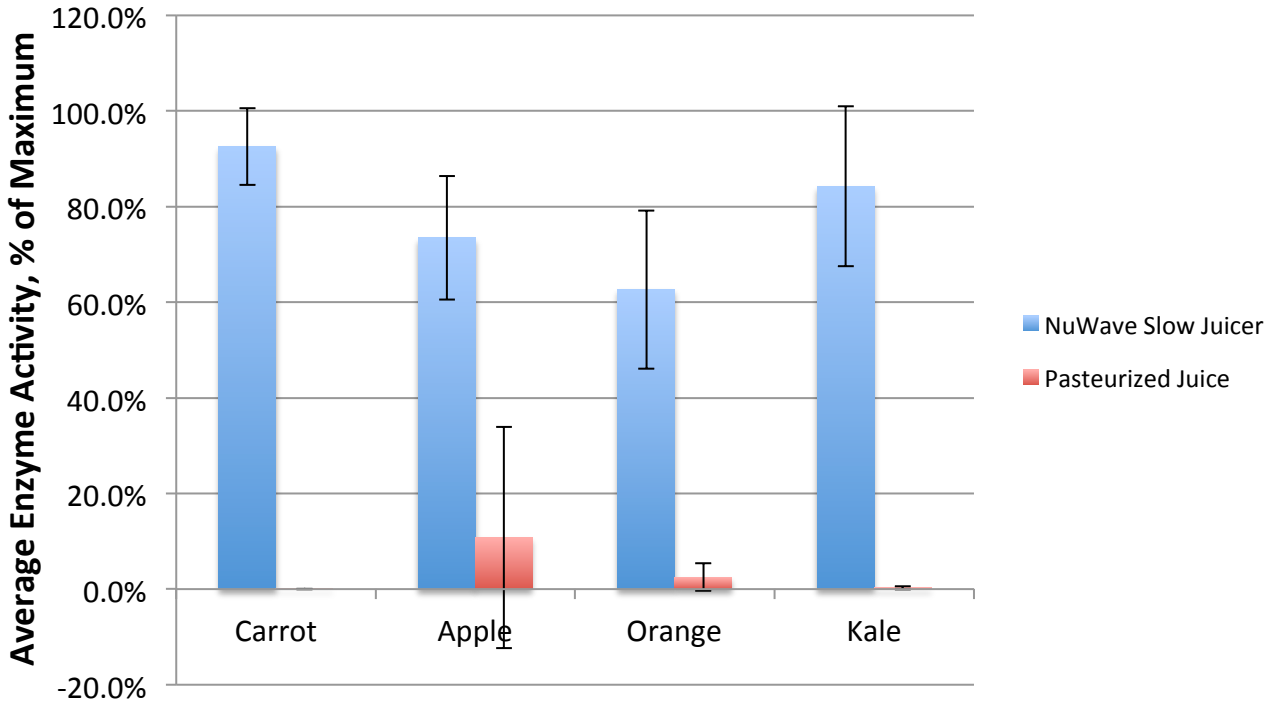
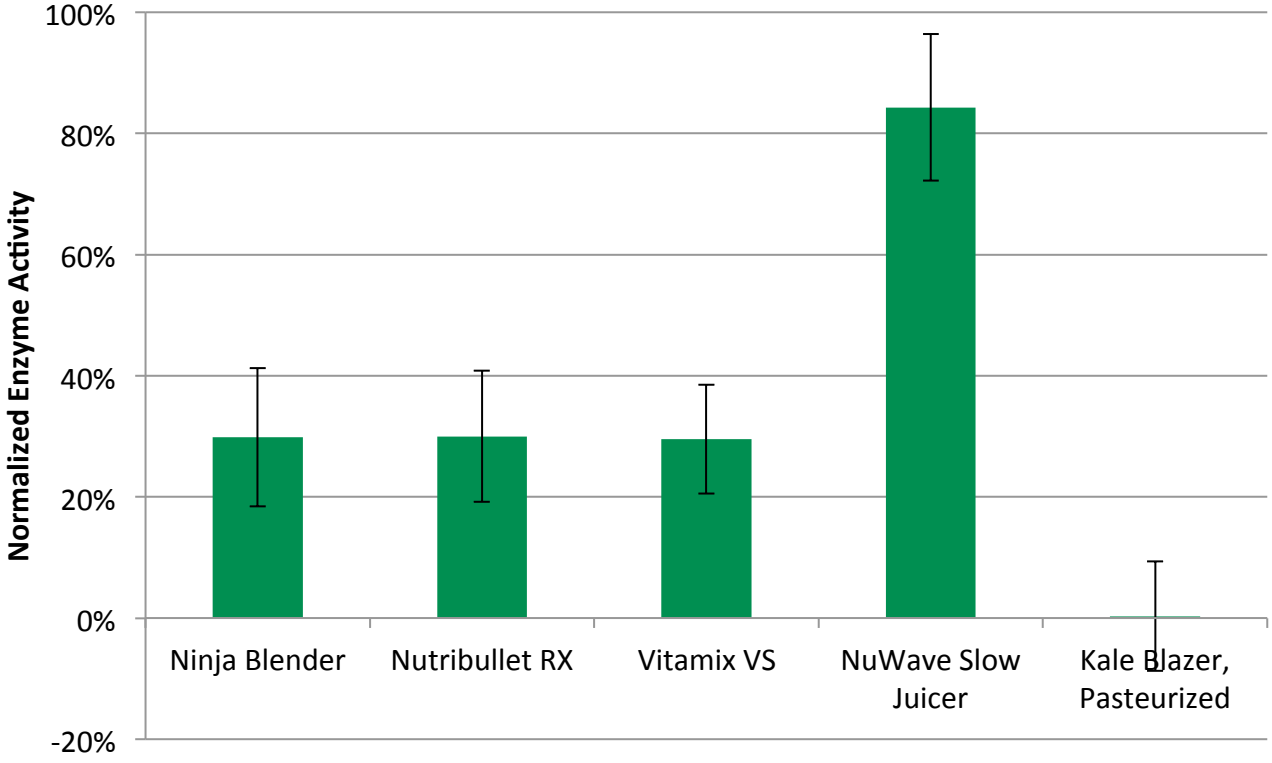
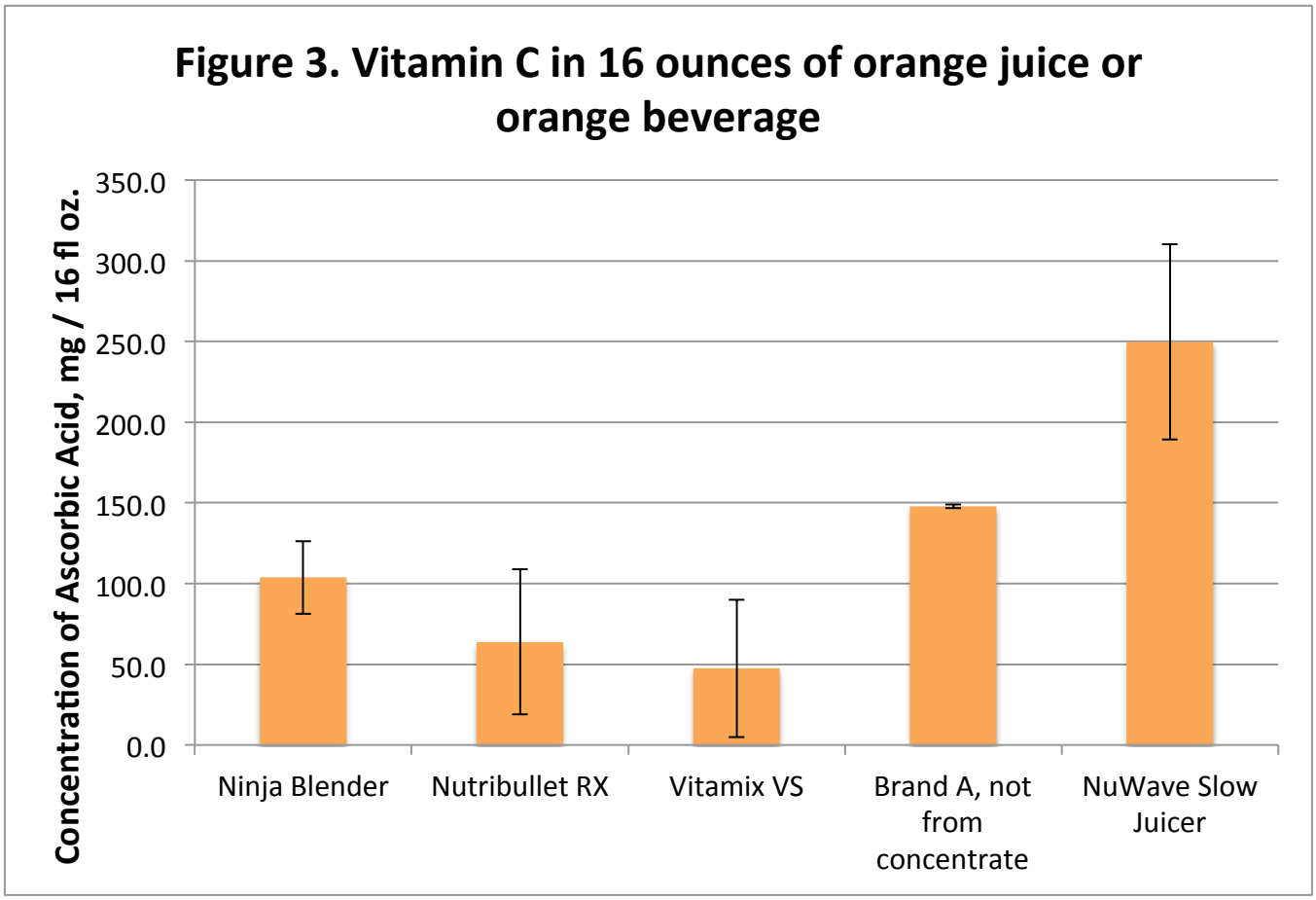


Figure 2. Average Enzyme Activity, Kale Juice



Vitamin C in Orange Juice. Oranges are commonly associated with vitamin C. While the other produce had very low levels of ascorbic acid, the fresh oranges actually have substantial amounts. As seen in Figure 3, the orange juice made in the NuWave slow juicer contains more vitamin C per 16 ounce serving than purchased, pasteurized, not-from-concentrate orange juice. This indicates that fresh orange juice from a juicer is a significantly better source of vitamin C than processed orange juice. Because of the results with vitamin C, it is likely that other heat sensitive nutrients are more abundant as well in the freshly made orange juice, as well as the enzymes that are all deactivated in pasteurized orange juice.

On a 16-oz serving basis, there was a vast difference between the beverages produced in the blenders and the juicers. Even taking into account the 50% dilution in the blenders, there was a significant loss of vitamin C in each blender. The more powerful the blender, the stronger the effect was as well. The loss of vitamin C was not as great in the Ninja, at about 103 mg per 16 oz serving, but was progressively worse in the Nutribullet (64 mg/serving) and in the Vitamix blender (47.5 mg/serving). Ideally, there should have been about 125 mg of vitamin C per 16 ounces of blender beverage, based on the almost 250 mg of vitamin C found in 16 ounces of juice from the NuWave slow juicer. This would indicate that there was a great deal more oxidation that occurred during the blending action compared to the more gentle slow speed of the NuWave slow juicer. Other sensitive nutrients may also have been destroyed as well in the blender. The blending did not have a substantial effect on enzyme activity, but the loss of vitamin C during blending is quite noticeable and significant.



Conclusions

Pasteurized or Homemade? The evidence presented here shows that pasteurization destroys all enzyme activity in bottled juice. These pasteurized juices lack the enzymes and living vitality found in fresh juices. The benefits that have made fresh vegetable juices a cornerstone of many health programs are not possible when using pasteurized juice.

Blender or Juicer? When a person wants to seriously increase their intake of vegetables, a juicer is the best choice. A blender does well for making smoothies, but they make terrible juicers. Carrot juice really cannot be made in a blender, regardless of how a company's marketing campaign spins the facts. The watery, pulpy, hard-to-swallow "juice" from a blender pales in comparison to the rich, robust, deep flavored juice from a real juicer. When a person wants to regain their health and rebuild the body at the cellular level, it requires a lot of vegetable nutrition that can best be obtained with a juicer. If a person wants to maintain their excellent health, then a blender enables them to make smoothies and blended salads. This habit is easier to maintain than juicing, but a person's vegetable intake is probably not as great as when using a juicer.

Another factor is the oxidation damage to the produce that was uncovered in this investigation. While enzyme activity did not diminish during blending, there was a very clear, reproducible, and significant loss of vitamin C during a 2 minute blend cycle. The amount of blending necessary to make a beverage smooth will likely consistently cause depletion of vitamin C and possibly other sensitive nutrients.

For these reasons, a high-quality juicer is an excellent choice for a person who wants to improve their health, or is confronted with a significant health challenge. The NuWave Slow Juicer is a solid choice and consistent performer for someone who is serious about their health.