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The Miscommunications Between Nutritional Scientists and Mainstream Media with Regard to Acai Berry (Euterpe Oleracea)

Rudi L. Hanekamp Mr.
rhanekam@uwyo.edu

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Rudi Hanekamp

Senior Honors Project

Mentor: Dr. Michael Liebman

University of Wyoming

Laramie, WY

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Acai berry history

Looking back to the years 2008-9 a new miracle product, discovered in the depths of the Amazon rain forest, had hit the multimedia platforms of America. This product was featured on *Oprah*, *The Dr. Oz show, FOX News, The Drs,* and even *CNN.* It claimed to have "10x the antioxidants of grape juice," make your skin look younger, and may even fight cancer (FOX; Oprah; CNN, 2008). According to Google, the number of searches for the word "acai" peaked around 2009 (Figure 1.) However, since that 2009 peak of the initial popularity of acai berry, it has decreased substantially. If a person were to search for acai products in 2017, they would mostly likely find a combination of frozen acai pulp being sold on Amazon aside articles questioning whether acai is a supper food or a nutrition scam. This paper will address the stark contrast between information presented in the media and the research finding of various nutritional scientists. Furthermore, this paper will seek to understand the sources of miscommunication between researchers and the media and propose one potential solution that could help the nutritional supplement industry as a whole.

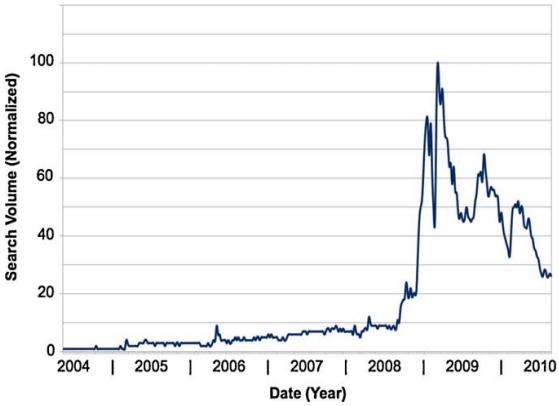

Fig 1. Google Trending for "acai" (Heinrich et al.)

Origin and economic impacts of acai berry

Euterpe oleracea (Acai palm) is a palm tree that is located throughout the Amazon basin and is one of the more widely spread palm species. The palm naturally grows in floodplains, and swamp lands along the far edges of the Amazon River. It is one of eight known species of berry palm and has bundles of deep purple berries when in fruit. The acai berry's seed, takes up the 75-90% of the weight of the berry. The skin and rind are the only parts of the palm that are used as a nutritional supplement.

In 2010, the country of Brazil exported 68 million dollars of acai products to the United States alone (Heinrich et. al, 2011). Due to the amount of labor needed to make a bottle of pure acai juice, the product can often sell for $30-40 USD depending on its quality. During the sharp rise in interest following the joint Dr. OZ Oprah segment, there was a 32% industry wide sales increase in the 2009 fiscal year (Kimball, 2015). The immediate increase in the international market made the berry almost unaffordable to local Brazilian populations, some of which count on acai for 42% of their daily caloric intake (Heinrich et al, 2011; Kimball, 2015). Although interest in the product had declined according to Google, the industry has not. The annual industry net worth of acai, according to an article on futuremarketinsights.com, is currently around 1.8 billion, and is expected to grow 2.2 billion by 2026 (Future Market, 2016).

Claims by the media

Super foods and cure all's are nothing new. Coca-Cola had its first bottles sold at a pharmacy in Georgia as a remedy for nerve disorders, headaches, and impotence (Pendergrast, 2000). What is new is the use of scientific research by the media to make a product seem more endorsed by scientific research. The first examples I found of this were in books published by Dr. Nicholas Perricone. He wrote 2 paperbacks called *The Perricone Promise* and *The Perricone Prescription,* which discussed how acai and other supplements could help reduce aging. In these books, he claimed that antioxidants and anti-inflammatory agents could take "10 years off your life in just 28 days" and the anti-inflammatory properties of acai would make you look younger, and add years to your life (Perricone, 2009). Due the lack of any longevity studies done on humans with regards to acai, these claims were largely unverifiable and had very little research backing them.

The second source of claims was from new segments on *Fox News* and *CNN*. The first of these was on *Fox News*. They claimed that recent cancer research found acai berry extract could kill 86% of leukemia cells in test tubes and maybe a useful for cancer treatment. Secondly, *CNN* claimed acai was incredibly beneficial for weight loss and may even be the next big diet trend. Thirdly, both media outlets claimed that acai was packed full of antioxidants much more than what you would find in grapes, strawberries, or

blueberries. Finally, *Fox News* encouraged viewers to go out and buy acai products because there were no known negative side effects regardless of dose taken (Fox News, 2009; CNN, 2013). Many of these claims are echoed on the *Oprah* show, various web sites and product advertisements on the internet.

Acai and nutrient content

Before trying to determine what components of acai are having effects, researchers analyzed the chemical makeup of acai pulp. An article in *Phytochemistry letters* by Schauss et al., 2006 analyzed the same acai trees over several years to determine the most common chemical makeups for the fruit. Time of year was not specified. Their results are shown below in Fig. 2 and Fig 3.

Fig 2. Nutrients per 100g dry weight

Total Calories	533.9 cal
Fats	292.6 cal
Protein	32.5 cal
Carb	208.8 cal
Dietary fiber*	44.2 g
Sodium	30.4 mg
Vitamin A	1002 IU
Vitamin C	<0.1 mg
Calcium	260.0 mg
Iron	4.4 mg

(Schauss et al., 2006)

Fig 3. List of Antioxidants and Polyphenols

Names	Total weight per 100 g sample
Anthocyanins (Cyanidin-3-rutinoside, Cyanidin-3-glucoside, Cyanidin-3-arabinoside, Cyanidin-sambubioside, Peonidin-3-glucoside, Pelargonidin-3-glucoside)	**88-211mg/ 100g dry weight**
Flavonoids (Homo-orientin, Orientin, Isovitexin, Catechin Epicatechin, Proantocyanidin)	**1289 mg/100 g dry weight**
Mono and polyphenols (Protocatecuic acid, Hydroxybenzoic acid, Vanillic acid, Feulic acid, Syringic acid, Resveratrol, Gallic acid, Benzoic acid)	**13.9 mg/100 g dry weight**

(Schauss et al., 2006)

Additionally, when acai was compared with 18 other lesser-known fruits from Brazil, acai did not stand out as having an unusual amount of antioxidants (Schauss et al, 2006)(Heinrich et al., 2011). The main antioxidants of interest were the Cyanidin-3- groups as well as the Catechin and Proanthocyanidins. Although none of these are unusual, it is thought that some combination of them may have additive or synergistic effects (Del Pozo et al., 2006). Although the two tables above show that acai has a significant amount of antioxidants, it also illustrates that the majority of the fruit pulp contains ordinary macronutrient compounds.

Acai antioxidant stability during spray-drying process

The following study focused on the stability of the antioxidants when treated with the spray-drying process, a common practice in the nutritional supplement industry. Antioxidants are notoriously unstable chemical compounds that can change chemical composition when exposed to high temperature, light, and even oxygen. The researchers believed that the antioxidants could have been altered when exposed to the 140° C temperatures that are used to prepare acai in the spray drying process. Researchers harvested the acai berry and froze it within 6 h post-harvest to prevent antioxidant breakdown. They then sprayed the acai pulp juice with maltodextrin, maltodextrin 10DE, maltodextrin 20DE and tapioca starch. Antioxidant breakdown was measured over the next few months and years (Tonon et al., 2011).

Results of Tonon et al., 2011

In the spray drying process, there was very little breakdown of many of the anthocyanins with 3946.14 mg/100 g before spray-drying and as high as 3436.85 mg/100g after the spraying process. A difference of only 510 mg antioxidants is considered "very good" according to the researchers (Tonon et al. 2011). All four compounds showed similar chemical reaction rates with the maltodextrin 10DE being the highest. They all had higher reaction rates up to 45–60 days of storage and a half-life of between 1248 and 814 days. This method of processing of acai juice seems to be extremely effective (Tonon et al., 2011).

Acai bioavailability in humans

In a study by Manach et al., 2005 the researchers were interested in the degrees of bioavailability of the different antioxidants. Many of the *in vitro* studies were based on the assumption that the concentration of various antioxidants would be sufficiently high in the bloodstream to be obtained experimentally. This study examined the relationship between the amounts of antioxidants consumed and the concentrations found in plasma or urine.

97 different polyphenols and antioxidant sources were studied to determine their absorption percentages. Although acai was not directly studied, its most prominent antioxidant group's anthocyanidins, and catechins were assessed. For the meta-analysis, studies were analyzed in which subjects had been given different foods that would provide a target level of antioxidants consumed. They compared antioxidant intake with subsequent plasma and urine concentrations of those antioxidants. The average percentage of antioxidant transferred across the intestinal endothelium was calculated (Manach et al., 2005).

Results of Manach et al., 2005

The overall results showed that compounds such as gallic acid and isoflavonoids (found at relatively low amounts in acai) were very efficiently absorbed while anthocyanidins and catechins (found at relatively high amounts in acai) were comparatively poorly absorbed (Manach et al., 2005).

Anthocyanins

The anthocyanins were one of the most poorly absorbed and there was a large range of values depending on the food source. The highest amount absorbed was from black currant juice; 5.35 μmol/L for each gram consumed. The lowest concentration observed was only 0.02 μmol/L per gram from grape juice. The urine concentrations had total excretion levels ranging between 0.02% for black currant juice and 5.1% of original antioxidant consumed for red wine (Manach et al., 2005).

Catechins

The catechins were the most poorly absorbed of the antioxidants but had a much higher urine concentration rate compared to the anthocyanins. The highest plasma concentration study for pure catechin showed 2.95 μmol/L per gram while the lowest study showed 2.2 μmol/L per gram consumed. The highest urine excretion was 55% of catechins consumed while the lowest urine excretion was 3% of product consumed urine excretion.

As a side note, the researchers went on to state that many of the antioxidants were changed from their original form when they crossed the endothelium of the small intestine. This often negates their antioxidant benefits (Manach et al, 2005). Fortunately,

some versions of the catechins are one of the few antioxidants that undergo very little change after being absorbed. Therefore, some of the claims from *in vitro* cancer studies described below, may be unrealistic due to low percentage absorption of key compounds provided by the acai berry.

Effect of acai on cancer cells

In the first experiment performed by Hogan et al., researchers studied the effect of various fruit anthocyanin extracts on the growth rate of cancer cells (Hogan et al., 2010). Acai powder was procured from a company in Brazil, treated with acetone, and organic acids, the remaining minerals were then washed away with distilled water. This was done to isolate the anti-oxidative properties of the acai berry. This process was repeated for other antioxidant rich products such as blueberry and wolfberry. Distilled water was used as an experimental control. The cancer cells were drawn from two sources: C-6 rat glioma (brain tumor) and MDA-468 human breast cancer cells. The growth rate of the cancer cells was measured for 24 h before introducing the various compounds to assess changes in growth (Hogan et al., 2010).

Results of Hogan et al., 2010

By comparing the effect of extracts from various fruits on cancer cell survival, the researchers found that the acai extract had the most potent effect on inhibiting cancer cell growth (Fig. 4). This effect was determined to be a dose-dependent response in the rat C-6 glioma cells. The researchers found that at 50 µg/ml of acai antioxidant, 62% of the tumor cells survived compared with 45% survival at 100µg/ml and only 38% survival at 200 µg/ml. The researchers found no suppression with the MDA-468 breast cancer cells. They hypothesized that the decrease in cell viability and growth was due to apoptosis induced

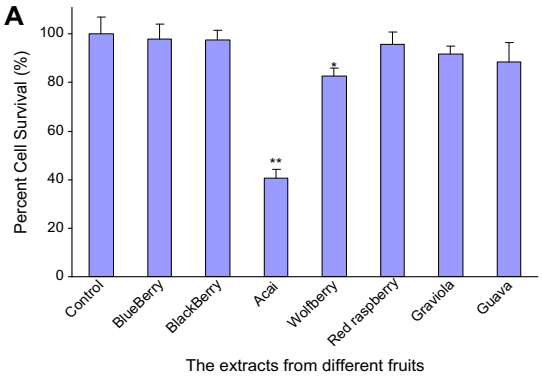

Fig. 4. Cancer cell survival after exposure to acai extracts and other fruits (Hogan et al., 2010).

by the acai extract. Although this study was an in vitro experiment, the findings were significant because they used antioxidants at levels that could potentially be achieved in the bloodstream and would likely not be lethal to humans. The fact that there was no effect on the breast cancer cells suggests that only some types of cancer maybe benefited by acai.

Effect of acai on HL-60 leukemia cells

The experiment conducted by Del Pozo et al., 2006 assessed acai antioxidants with slightly modified chemical structures and how they affected HL-60 Leukemia cells. This experiment was of particular interest because it was directly referenced on Fox News and used as evidence for acai treating cancer (Fox News, 2011). The researchers used pasteurized, frozen acai pulp shipped from Greeley, Colorado. They used various hydrolysis factions to isolate polyphenols, glycosides and aglycones. These are modified versions of the anthocyanin antioxidants and they conducted this for 8 different fractions. The researchers then compared the leukemia treated with acai factions over a 24-hr and 48-hr time period and compared the results with a control of untreated leukemia cells. In this experiment, researchers measured two factors, cell death rate and cellular caspase-3 activity. Caspase-3 is a rate limiting, essential, enzyme in the apoptosis of human cells. The researchers measured this instead other compounds because they believed that some of the antioxidants in acai were beneficial to activating the self-destruction process in cancer cells. For the experimental control, the researchers measured the caspase 3 activity and growth rate of untreated leukemia cells (Del Pozo et al., 2006).

Results of Del Pozo et al., 2006

When acai fractions (I-IX) were introduced to the HL-60 leukemia cells the researchers reported a number of positive results. At 0.17-μM, cell death rates between 36%-49% were found. These percentages increased all the way to the highest dose, (10.7μM), where a 56%-82% cell death rate was found. The effect of the *in vitro* acai treatment was also time dependent, becoming most effective after 3h, and completely ineffective after 6h. The researchers found between a 5-fold and 8.2-fold increase in

caspase-3 activity depending on the dose of acai (Del Pozo, 2006). What was most significant about this experiment was the dose and time dependent reaction of the capase-3 enzymes, which seemed to respond in varying amounts to acai pulp fractions. By the researchers own admittance, their findings should not be directly extrapolated to a human model for several reasons. Firstly, the doses used would be hard to achieve in the human blood stream with just acai consumption. Secondly, the experiments did not find if acai's effects were limited to the leukemia cells or if they would have the same effect on any type of cell, cancerous or otherwise. Thirdly, the scientists manipulated the acai fractions; their experiment researched the glycone and aglycone forms of the antioxidants in acai rather than the pure pulp compounds. Finally, the researchers hypothesized that when acai is taken with other foods, it may nullify its pro-apoptotic effects. Although this was a great paper for antioxidant effects on leukemia, it was a huge leap by the media to claim acai had cancer controlling properties.

Acai and metabolic biomarkers

It was relatively difficult to find scientific studies that reported weight loss caused by acai. For this reason, Web MD was used in place of scholarly literature and revealed the best sources for public information gathering. The Web MD article concluded that the jury was still out as to whether acai can help with weight loss or other anthropometric benefits (Web MD, 2017). Part of the problem may stem from the lack of communication between the media and researchers. The lack of research may be due to the scientific community seeing no physiological reasons why acai would cause greater weight loss, and deemed the research a waste of resources. Although verification of this claim may not be feasible for this paper, there were more resources on acai's effect on metabolic biomarkers.

Effect of acai on metabolic syndrome in overweight population

Although there has been a fair amount of research on the effect of acai in vitro and in animal models, there has been relatively little research in human studies. The researchers conducted this pilot study on acai to assess its effects on metabolic syndrome parameters

in a healthy overweight population. In this study they used a sample of 10 participants with a BMI $\geq$ 25. The study group was fed 100 g acai pulp 2x daily for a month (30 days) with no other changes to their diet. Fasting plasma glucose, insulin, cholesterol, triglycerides, exhaled nitric oxide metabolites (eNO) and plasma levels of high sensitivity C-reactive protein (hs-CRP) were measured before and after the experiment and then compared. This pilot study had no control groups, however they thought it was justifiable to measure analytes in the subjects at the beginning, for a baseline value, and at the end (Udani et al., 2011).

Results of Udani et al., 2011

After a month of the diet containing acai, the study found that compared to baseline measurements, there were significant reductions in fasting glucose, insulin production, and in serum LDL and total cholesterol. There was not a significant difference in nitric oxide or C-reactive proteins, which suggested that acai did not have an anti-inflammatory effect. The study itself concluded that it had insufficient evidence to make claims about acai's effect on serum cholesterol levels and further *in vitro* as well as in vivo studies would be required (Udani et al., 2011).

Effect of acai on lipids and antioxidants

A study by Pala et al. (2017) was aimed at discovering whether acai could be beneficial for heart health in women specifically. Forty women between the ages of 21 and 27 were given a once daily total 200g of thawed frozen acai pulp for 28 days (Pala et al. 2017). Blood samples were taken at the beginning and at the end of the study and required a 12hr fasting period to eliminate temporary post-meal metabolic changes on biochemical levels. The researchers measured fasting glucose, insulin, LDL, HDL and total cholesterol, homeostasis models of insulin resistance (HOMA-IR), apolipoproteins A-1 and B, and triglycerides. To verify that the biomarkers were not related to anthropomorphic changes, blood pressure, BMI, and percent total body fat were measured before and after as well. The researchers explained that they did not use a control group because they

predicted that it would be too difficult to find people that would continue to the end of the study (Pala et al, 2017).

There were two main parts of the study. They analyzed changes in the serum levels of various metabolic biomarkers in the women, and they also conducted an in vitro experiment with radioactive lipids to assess if there would be a change in the movement of lipids into HDL.

Results of Pala et al., 2017

After the 28-day feeding period the researchers found no significant changes in fasting glucose, fasting insulin, LDL and HDL cholesterol, apolipoprotein B and fasting triglycerides. This was additionally significant because the average anthropomorphic measurements had remained statistically unchanged (Pala et al, 2017). The first significant finding was that they observed an increase in total antioxidant capacity as well as a decrease in reactive oxygen species (ROS). Several ROS, such as oxidized LDL and neutrophil ROS were decreased suggesting that acai is a strong antioxidant. Next, they found that Apolipoprotein A1 was increased. This was an unusual finding because the serum ApoA1 level is usually predictive of the level of serum HDL. However, HDL did not increase. This may suggest that there was an increase in the amount of ApoA1 per HDL, a result which could have functional significance. Lastly, they designed an in vitro assay to evaluate the movement of radioactive cholesteryl esters into the serum HDL of the study subjects. They determined that after acai treatment, a greater amount of phospholipids and cholesteryl esters moved into the HDL fraction of the patient serum in vitro. The researchers proposed that this result might suggest that the post-acai HDL would have a higher cholesteryl ester carrying capacity. This in turn could mean that a greater transport of cholesteryl esters from the arterial wall to HDL could result in better overall cardiovascular health. The researchers also concluded that acai was beneficial for heart health due to its higher fiber and antioxidant capacity.

Animal study supporting findings of Pala et al., 2017

A final study not based on a human model, involved control groups and showed similar results to the study above and is worthy of mention. The following study by De Souza, et al. (2012) found that acai ingestion was correlated with a decrease of plaques on rat arterial walls. These researchers believed that this was in part due to an increase in expression of rat LDL receptor (LDL-R) genes.

Acai and safety

In the original press release, CNN claimed that there were no counter indications to suggest that acai berry is a dangerous product (CNN, 2013). However, there is evidence concluding that other products added to acai berry extract can be quite dangerous, as described below.

Misrepresentation of acai content in supplements

A SOAP Note from 2012 described the case of a 22-year-old man who developed rhabdomyolysis. This is a rare disorder, which combines muscle breakdown paired with kidney failure from dealing with the extra nitrogen released from protein breakdown in the muscle. The young male had been taking an acai berry supplement for 2 weeks for weight loss reasons. He was admitted to the hospital and discharged 5 days later. When the man presented a sample of the health supplement he had been taking to the doctors, they found that there was no acai berry in the pills and the supplement contained unknown contaminants. Therefore, if acai is falsely listed as an ingredient in weight loss supplements, some of the negative effects from other chemicals might be attributed to acai. (Elsayed et al. 2011).

Health Canada warning on mislabeled acai products

A public health warning from *Health Canada* warned against the purchase of *Anti-Aging Acai*, *Brazilian Pure*, and *Dietary Supplement Acai Power Blast and Muscle Mass,* all of which were the actual names of the products (Health Canada, 2010). The article claimed the products contained an undeclared drug called Sildenafil; most commonly known by its brand name, *Viagra.* There were several reported cases of headaches and dizziness as well as other side effects that had very little to do with the chemicals the products claimed to contain (Health Canada, 2010).

Malaysian ban on all acai products due to *Acai Berry ABC*

A study published recently in 2016, conducted by researchers at the University of Teknologi in Malaysia, studied effects of ingesting chewable weight loss soft gels labeled *Acai Berry ABC*. By testing the product and analyzing other product reviews, they concluded the product was tainted with Sibutramine and put *Acai Berry ABC* on the banned drugs list. Siburtamine is a currently banned prescription weight loss supplement that works by inhibiting the reuptake of dopamine, serotonin, norepinephrine, and catecholamines that may increase the feeling of satiety from the user. Although this product was found to lower insulin levels and increase weight loss, it was also found to have the potential side effect of non-fatal myocardial infarctions and strokes. This was particularly troubling due to the fact that the product claimed that it would "turbo charge weight loss" and gave no indication of how many gels to take. Other acai products in addition to *Acai Berry ABC* were banned in Malaysia for being unregistered foreign products and containing chemicals, which could be poisonous in high doses. There was no mention of Sibutramine on the label and no warnings about the potentially dangerous product inside. A simple web search showed that the product is still on sale on eBay for the low price of $11.

Conclusions

When comparing the information presented in the media with the scientific studies in this paper, there were some very apparent leaps in communication.

The media's claim that acai contained huge amounts of antioxidants did not hold up. Acai's antioxidants were comparable to other palm fruits and were relatively poorly absorbed. The claim that it was beneficial for inhibiting some types of cancer seems to be true in *in vitro* studies but not a human model. Acai's apoptotic affects in vitro, are nullified by its very small amount of absorption as well potential negative interactions with other foods and human physiological systems. This makes it unrealistic to be considering for human cancer treatment just from consuming the pulp. There doesn't seem to be any correlation with weight loss other than reduced calorie intake. Evidence does suggest that acai reduces reactive oxygen species, increases the total antioxidant capacity and may even improve the function of HDL in people. The acai berry seems to hold up well to high heat processing as well as freezing. It contains a large amount of anthocyanins and catechins as well several other flavonoids before and after. This suggests that non-native consumers would receive the same nutritional benefits as eating the fresh berries. The berry itself is a safe nutritional supplement, but due to the lack of regulation in the online nutrition industry the product has a significant chance of containing unwanted chemicals, especially if it is being sold as a skin care or weight loss supplement.

Possible Solutions

In 2010, Dr. Oz and Oprah filed lawsuits with over 40 companies for claiming they endorsed their companies' acai products. Some defendants were charged with extrapolating and fabricating quotes, especially ones claiming acai as a weight loss supplement. Others had merely used Dr. Oz or Oprah's name to sell phony, dangerous products. The problem wasn't with the acai berry itself but rather the way Oprah and Oz presented acai as a supplement that could potentially cure everything. In the long run, this caused a fair amount of back peddling confusion and a borderline distrust for the fruit. The Google trends graph in Figure 1 of this paper was a direct result of unsubstantiated claims

and the public's conclusion that if it didn't live up to one of its claims then the whole supplement must be a farce. It is apparent that acai and other berries in the *Euterpe* family do warrant further attention nutritionally and medically. That attention, however, must be supported, shared, and sold as a nutritional medicine rather than a fad diet. Many people believe and trust in the media for their health and life choices. If the communication between the media and the scientific community were more prominent, not only would people have better reason to trust the media, but there could also be some real nutritional advances too.

In the paper, *Overcoming the Scientist Journalist Conflict*, the American Association for the Advancement of Science stated, "Journalists are more compelled to understand scientists than scientists are compelled to understand journalists," (Rowe, S. 2010). The paper went on to explain that with a large decrease in consumption of newspapers in favor of snap chat or the internet, the majority of news companies are hiring fewer and fewer journalists. This, in turn, meant journalists had to be able to write on a large variety of topics and made the likelihood of a journalist with a strong background of reading scientific articles very small. Additionally, a study done by the *Royal Society of England* showed that many scientists considered talking to the media as a behavior "unworthy of serious scientific endeavor," (Ludlow, 2006). Despite this, much of nutritional research is either directly or indirectly funded by public interest. This is not only through government grants or donations but also by providing a pool of potential future researchers. I propose that major media outlets have connections to databases similar to *Up-to-Date* for doctors or *Nutritionally Aware* for pharmacists. At the very least the media would be gaining edited statements about products rather than attempting to piece together oversimplified conclusions directly from the research studies. Since most news agencies are trying to get the most current, exciting, new information, the database could be set up so that news agencies could request certain studies to be conducted for their stories. This could extend the very fast news cycle to a few months rather than hours or days, giving journalists time for accurate information. It would be a very large task for both researchers and media alike, but the result would be more accurate information distribution and a better public understanding of nutritional supplements like acai.

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