Comparing The pH Of Human Skin To The pHs Of Different Water Treatments

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Abstract

The pH of multiple water treatments were tested to determine which was closest to the pH of human skin. Water pH and its effects on human health is a growing area of interest for consumers and scientists. Studies have identified that the average pH range of skin is below 5 which can be altered by the water that is consumed or used (Kulthanan et al., 2013; Lambers et al., 2006). This experiment tested 3 different water treatments, tap water, alkaline water, and distilled water, and used 3 different pH indicators, red cabbage, red apple skins, and blueberries. It was hypothesized that if the pH indicators are accurate then the pH of distilled water would be closest to the pH of skin because distilled water is studied to have a pH closest to the pH of skin (Kulthanan et al., 2013). Using household items and cooking techniques, it was determined that neither of the water treatments have a pH similar to the pH of skin.

Introduction

Water is vital to the composition and maintenance of the human body. On the cellular level, water is essential in transporting nutrients and removing waste (Hausinger, 1996). Another topic of discussion is water pH. Numerous companies have established themselves upon the postulated effects of alkaline water while some members of the scientific community have either denounced it as nonsense (Schwarcz, 2017) or discovered nuances in effects towards physiology and sports performance. Alkaline water, also referred to as alkaline electrolyzed water (AEW), is tap water taken from the cathode side during electrolysis (Tanaka et al., 2018). While the pH of drinking water seems to have no effect on microbiota and glucose metabolism in males (Hansen et al., 2018), some respondents in other studies have reported improved sleep (Tanaka et al., 2018) and some athletes have seen improvement in high-intensity anaerobic exercise, hydration, and acid-base balance (Chycki et al., 2018). Moreover, water provides support to major constituents of the body such as cells and tissues (Jèquier, 2009). On the macroscopic level, this provides support to the body's largest organ: the skin. This waterproof barrier is made up of approximately 30% water (Madison, 2003) and is responsible for regulating what comes in and out. This function of the skin is aided by its acid mantle: another protective layer on top of the skin that has been suggested to prevent pathogenic entry. However, the functionality of the acid mantle is dependent on the relative pH of the skin, which is roughly 4.7 (Lambers et al., 2006). Interestingly, the pH of water can increase the skin pH (Prakash et al., 2017). Water pH has been suggested to influence skin irritancy, which can be detrimental for individuals with skin conditions such as atopic dermatitis or dry skin (Kulthanan et al., 2013).

Surprisingly, there is a lack of research examining alkaline and distilled water and its relation to skin pH. In this study, we examine the pH differences of water used in daily tasks such as washing hands in order to better inform individuals, especially those with skin conditions. Here, we focus on three different types of water: tap water, alkaline water and distilled water. Our aim is to identify which of these three different types of water will have a closer pH to that of skin. We hypothesize distilled water to have a pH within the range of skin pH as existing literature has suggested it to possess an estimated pH of 5 (Kulthanan et al., 2013).

Methods

The water treatments were separated into 3 containers, one for the store bought distilled water (500 mL), one for the kitchen sink tap water (500 mL), and another for the store bought alkaline water (500 mL). Next, the containers were labelled with its water type and stored in the fridge at a temperature between 10-15°C. The pH indicators were prepared using ½ head of red cabbage, 2 red apples, and 1 pint of blueberries. This was done by cutting up the red cabbage, peeling the skin off the red apple, and cutting the blueberries in half using a knife and cutting board. Then each fruit was placed into 3 separate bowls of boiled water for 1 hour to allow the pigments to dilute the water. Once the water has cooled and turned into either a dark purple, pink, or purple colour, the fruit was strained out of the bowl. 3 paper towel sheets each were cut up into 15 pieces and soaked into the solution and dried overnight. Once the pH strips have dried, each water treatment was tested on each pH strip type 3 times. The pH of the water was determined by comparing the pH strip result to the pH scale from an online source (Figure 1). The pH values were then recorded, tabulated, and analyzed using a two-way ANOVA. We generated a script using R to run the two-way ANOVA.

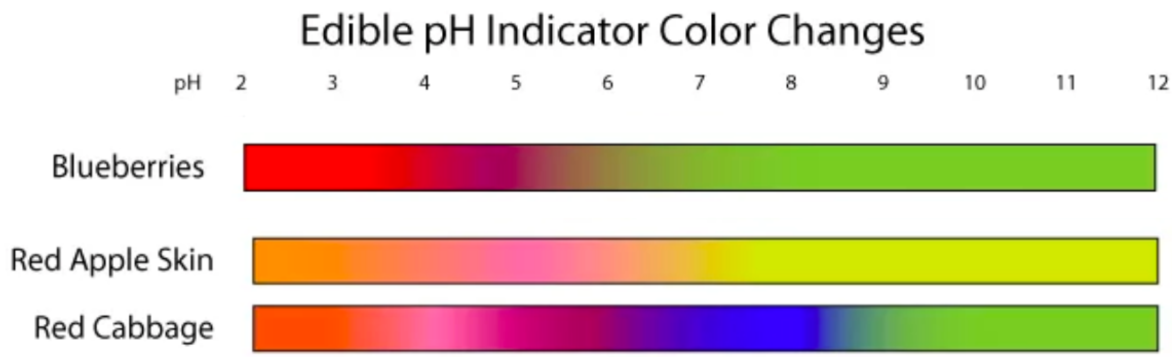

Figure 1. An excerpt from the published pH indicator chart (T. Helmenstine, 2019). Figure shows the edible indicators used in this study.

Results and Observations

The efficacy of the pH indicators and the pHs of each water type was determined through observational and statistical analysis. By comparing the resulting pH strips to the pH indicator chart (Figure 1), the data was gathered and prepared for the statistical test. The two-way ANOVA test was used to identify the significance of the pH indicator type and the pHs of each water treatment. It was calculated that the p-value for the red cabbage, red apple skins, and blueberry pH indicators was 6.17E-09, and the p-value for water types was 0.7551 (Figure 2). This indicates that the pH indicators were significant and the water types were not.

	df	SS	MS	F	P
pH indicator	2	22.117	11.058	50.334	6.17e-09
Water type	2	0.125	0.063	0.284	0.7551
pH indicator ✕ water type	3	2.292	0.764	3.477	0.0332

Figure 2. Two-way ANOVA table showing the relationships between pH indicator and pH, water type and pH, and the interaction between water type and indicator. Results suggest that observed pH is dependent on the type of pH indicator used ($p < 0.05$). Additionally, the interaction between water type and indicator used is highly significant ($p < 0.05$).

Discussion

The results from the two-way ANOVA statistical test was used to determine if there were any significant differences in the results of the different pH levels of the three water treatments (tap water, alkaline water and distilled water), or in the different pH indicators used (red cabbage, red apple skins and blueberries). These results show that the type of pH indicator has an effect on what type of water the pH but the type of water does not have an effect on what the pH.

These results suggest that pH is dependent on the type of indicator used and not on the pH of the water treatments. However, pH should not depend on the indicators used because it is used to examine the level of acidity or alkalinity of the fluid (A.M. Helmenstine, 2019). With that considered, the pH strips were faulty because it was unable to detect similar pH ranges between the three pH indicator types. In addition, the pH indicators contributed the experiments sources of error, one being that it was unable to detect small pH changes, and the red apple skin pH strips tested on Vancouver Island tap water and distilled water were unable to detect any colour change. As a result, data collection may have introduced bias and data collated from the red apple skin pH type was unsuccessful. Overall, the results from this experiment cannot be used to answer our hypothesis.

Although this experiment was inconclusive, future trials may relay more effective results. Improving the procedure, materials used, and how data was collected can effectively compare the pH of skin to the pH of different water treatments: the use of a laboratory, pH identification using chemical pH strips and pH probes, and data collection using technology can effectively and confidently determine the pHs of different water treatments (Kulthanan et al., 2013). Compared to our at-home experiment, many factors such as how the pH strips were prepared and methods of calculating pH may have affected the results. As such, if this experiment were to be reproduced it should be done in a laboratory setting using chemical pH indicators and proper laboratory techniques. In short, improvements on the execution of this experiment will best remove external factors and effectively determine the pH levels of different water treatments.

Conclusion

Determination of tap, distilled, or alkaline water had a pH closest to the pH of skin using different pH indicators was achieved using pH indicators made of red cabbage, red apple skins, and blueberries. We observed that the pH values of the water treatments were not significant enough to be the closest to 4.7, the pH of skin (Lambers et al., 2006), concluding that the hypothesis was not supported by the data. Although statistical tests suggested that the water treatments were insignificant and the pH indicators were significant, future trials using more effective pH indicators would determine more robust and reliable results.

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