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Determining Effects of Urine Flow Rate from Fasting, and intake of Water, Gatorade, or Coke
Introduction

Human being’s require a balanced internal environment to properly function, this ‘internal balance,’ is performed by homeostasis. The importance of homeostasis is regulating water, salt, plasma volume, and pH of plasma. Maintaining homeostasis is significant for the fact that chemicals such as oxygen and carbon dioxide are transported throughout the body by the process of osmosis and diffusion that depends on the regulation of water and salt.

Within the kidneys, there are three major processes that take place: glomerular filtration, tubular reabsorption, and tubular secretion. The functional unit of the kidney are nephrons that compose of a renal corpuscle and renal tubule. Glomerular filtration is the first process by which blood begins filtration at the glomerulus before being turned into urine. The glomerulus is surrounded by Bowman’s capsule and it receives blood from afferent arterioles. Filtration rate is determined by glomerular capillary hydrostatic pressure, Bowman’s capsule hydrostatic pressure, Bowman’s capsule osmotic pressure, and glomerular osmotic pressure. The material in the blood before filtration contains water, salts, urea, vitamins, glucose, and ions (such as Na\(^+\), K\(^+\), etc.). Once filtered, the blood travels away from the glomerulus via an efferent arteriole and tubular reabsorption becomes the next step.

Tubular reabsorption occurs at the proximal convoluted tubules, where materials from the filtrate such as nutrients, water, and ions are returned into the blood by peritubular capillaries and this is also where 100% of glucose is completely reabsorbed. Water is also reabsorbed at the descending loop of henle while Na\(^+\) and Ca\(^2+\) are also reabsorbed at the ascending loop of henle.
Tubular secretion mainly takes place in the distal convoluted tubules and this is where \( K^+ \), \( H^+ \), and urea are secreted by peritubular capillaries to be excreted in urine. Not only does tubular secretion secrete non-filtered material, but additionally regulates the pH in the kidneys. If your plasma has a high pH, bicarbonate ions are voided into the urine and consequently decreases the \( H^+ \) ions secreted and decreases the reabsorption of bicarbonate ion. Furthermore, if your plasma pH is low, \( H^+ \) ions are voided and as a result increase \( H^+ \) secretion and increases bicarbonate ions to be reabsorbed.

Three hormones are associated with regulating the makeup of plasma: Anti-diuretic hormone (ADH), Renin-Angiotensin-Aldosterone system (RAAS), and Atrial Nitriuretic Peptide (ANP). ADH works on the distal convoluted tubule as well as the cortical collecting duct to reabsorb water. ADH is secreted from the posterior pituitary gland, but synthesized in the hypothalamus and is stimulated by a decrease in plasma volume, blood pressure, and increase in plasma osmolarity. The receptors that detect these changes are known as baroreceptors and osmoreceptors. RAAS is synthesized in the Adrenal Cortex that is stimulated by a decrease in blood pressure, plasma volume, and \( Na^+ \) and inhibited by the opposite. The receptors for Aldosterone are found along the juxtaglomerular apparatus and they monitor blood pressure and \( Na^+ \). Renin is released into the blood when blood pressure is low which in a series of steps turns into Angiotensin I and Angiotensin I then turns into Angiotensin II in the liver. Angiotensin II is responsible for constricting blood vessels and releasing Aldosterone which then increases blood pressure (Human Physiology: From Cells to Systems, 2008). ANP is synthesized by atrial muscle cells from the heart and its receptors are found along the walls of the atria. ANP is stimulated by an increase in sodium concentration and impedes
the release of ADH as well as Aldosterone. ANP encourages sodium secretion and causes vasodilation of the afferent arterioles that increases glomerular filtration rate (Human Physiology: From Cells to Systems, 2008).

The purpose of this experiment is to determine the effects of urine flow rate from adult subjects during fasting and in taking of water, Gatorade, or Coke. Three types of liquids are used in this experiment because different liquids alter the internal environment of the human body that leads to different effects of urine production. My hypothesis for this experiment lists the following from greatest urine flow rate to least: Gatorade, Water, Coke, and fasting.

**Methods**

Prior to the experiment, important directions were given to the students. Students were asked to first go over the kidney structure and its function in maintaining homeostasis and then split into four groups: water, Gatorade, Coke, and fasting. Before the actual experiment began, subjects were told not to drink or eat five hours before except for one cup or 8oz. of water during the first two hours. Students are also required to empty their bladder one hour before the experiment begins and record the time.

For the experiment, students collected their urine in two urinary cups at 30-minute intervals starting from T0. After gathering information from T0, the urine was discarded and then the bladder was to be emptied at T30 and so on and so forth until T120, which was the final void. The drinking group started off by determining the amount of fluid they needed to intake by using the following equation:

\[
\text{ml of fluid intake} = \text{[body weight (lbs) x 7 mls/lbs]} \times 0.80
\]
The volume necessary was based on their body weight and was required to ingest their drink within 15 minutes. All subjects had to take a Labstix reagent strip and dip it into their urine to test the pH as well as any presence of blood, ketone, glucose, and protein; this was required only once. The colors Labstix were then matched with the colors on the container to see what was detected. Groups also had to calculate corrected urine specific gravity, which was utilized with a urinometer. The specific gravity of a liquid measures its density to water at a specific temperature and because water has a specific gravity of 1.000 so anything over that would contain solutes. The process of calculating corrected urine specific gravity was to subtract the subject’s urine temperature from 15ºC (temperature that urinometer was calibrated to), divide by 3 (because 0.001 needed to be added for every 3ºC above 15ºC), round that number to the nearest whole number, multiple that number by .0001, and finally add that to the measured specific gravity (which was simply reading the urinometer in urine).

Calculating urine flow rate was required and the equation for it was:

\[
\text{Urine Flow Rate (ml/min) = volume voided (ml)/duration since last void (min)}
\]

After all the data was gathered, every subject wrote their information down on a chart of the creating the combined data all the subjects.


**Results**

*Figure 1*: the class average urine flow rate (y-axis) versus time of void (x-axis)

Figure 1 presents the data collected of urine flow rate versus time of void from all of the subjects that participated. At T=0 each group remained consistent and stayed about in the same range. At T=30 water had the highest significant increase from every other drinking group. As well at T=30 Coke and Gatorade increased but not as drastically as water. At T=60, again water had the highest increase from every other drinking group standing at about 5 mL/min. Moreover at T=60 Coke and Gatorade increased to about 3.5 mL/min. Interestingly enough, at T=90 Gatorade had the highest increase from the other drinking groups standing at 7.55 mL/min and water second at 6.81 mL/min. At T=120 the class average urine flow rate dropped vastly from T=90. At this point, water and Gatorade both voided 4.93 mL/min. In T=0 through T=120 the non-drinking group’s urine rate dropped as time progressed while the other groups increased.
Figure 2 represents the data collected of the class average corrected urine specific gravity versus time of void from all of the subjects that participated. According to the graph, at T=0 the corrected urine specific gravity of the non-drinking group was the highest and following this was Gatorade, while coke and water were the lowest. At T=30, changes occur where Gatorade in fact increases to the highest average corrected specific gravity at 1.029. At T=60 all groups drastically dropped—especially Gatorade—whereas the non-drinking group became the highest corrected specific gravity at 1.024. At T=60 Coke drops a bit lower than water. At T=90 the non-drinking group increases to 1.027 while the drinking groups decreased once more. At the final time voided, T=120, the non-drinking group increases to 1.031 while the other groups average to about 1.013. Throughout T=0 to T=90 the water group’s corrected specific gravity dropped as time progressed whereas at T=120 water increased.
Table 1: Present the results of your urine analysis for blood, ketone, glucose, protein and urine pH

<table>
<thead>
<tr>
<th>Test Reagent</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>presence of blood</td>
<td>negative</td>
</tr>
<tr>
<td>presence of ketone</td>
<td>negative</td>
</tr>
<tr>
<td>presence of glucose</td>
<td>negative</td>
</tr>
<tr>
<td>presence of protein</td>
<td>trace</td>
</tr>
<tr>
<td>urine pH</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Table 1 presents the results of urine tested from T=0. The Labstix detected no presence of blood, ketone, or glucose was present except for a small trace of urine and the pH of my urine was 7.5.

There were a few errors with the results as information was missing resulting in either efficient urine or calculation errors. The renal data spreadsheet provided information from all the students, but calculating the averages on the spreadsheet also leads to some inaccuracy. The numbers were averaged with the available numbers provided so the area where there was no information should have had a zero in the space instead of nothing. Excel calculated the data with the available numbers so any numbers missing was ignored when the data should have been zero.

**Discussion**

The purpose of this experiment was to study the osmotic regulation of the kidneys in maintaining fluid balance in the body with correlation of hormone regulation. We analyzed and compared the urine flow rate and specific gravity of students during fasting and following an ingestion of water, Coke, or Gatorade. Furthermore, we tested urine sample for blood, ketone, glucose, protein, and pH with a Labstix strip at T=0. My initial hypothesis of Gatorade being the highest flow rate is valid according to diagram 1.
The reason why Gatorade produced the highest urine flow rate is because of the high amounts of electrolytes that are found in the content. When the ECF has a surplus of H2O or a particular electrolyte, the kidneys can eliminate the excess in the urine (Human Physiology: From Cells to Systems, 2008). The electrolytes in Gatorade will firstly increase plasma volume and blood pressure. The plasma osmolarity will remain isoosmotic. Eventually the plasma osmolarity will be hypoosmotic and Na+ will increase osmosis into the vascular system and the uptake of glucose in the cells. Breaking down glucose will lead to an increase of water in the blood. These conditions will lead to inhibition of ADH and secretion of ANP. The heart, together with its pump action, manufactures ANP. ANP is built in the atrial cardiac muscle cells and is kept in granules and released when the heart muscle cells are stretched by an expansion of the circulating plasma volume when the blood volume is increased. The principal work of ANP is to immediately impede Na+ reabsorption in the distal parts of the nephron, thereby increasing Na+ and go with osmotic H2O excretion in the urine. As a result, Gatorade has the highest urine flow rate to all groups since the excretion of excess Na+ accompanied by water excretion.

When the body detects a low plasma volume, it will attempt to retain as much water as possible. Secretion of ANP decreased while secretion of ADH increased. The increased ANP caused decreased remove of sodium and then vasodilation of the afferent arterioles is decreased meaning a lower glomerular filtration rate (Castrop et al., 2010). In Castrop’s study, he mentions that ADH also adjusted renin release, but there is ongoing controversy about whether it increases or decreases renin release. In our case, it would seem as renin release would be increased to hope counter act the lost of fluids. For
the drinking groups, it made sense that urine production increased because plasma volume within the body increased. Secretion of ANP increased for all the drinking groups while secretion of ADH decreased. With the non-drinking group, blood pressure decreased which lead to the decrease in glomerular filtration rate while blood pressure increased for the drinking group (Kobori et al., 2007).

The reason for avoiding food and fluid intake before the experiment was an attempt to keep the experiment controlled. If these rules were not followed, the data produced would have been skewed meaning the correct result may not have been produced. From my evaluation some of the information provided was incorrect because some people perhaps did not follow the general procedure. For example, if the subjects from the non-drinking group drank soda, coffee, tea, water, or any liquids before the experiment, their urine flow would be higher than it should be. This would create an outlier within the collected data possibly throwing off a graph. To have the experiment produce accurate results, these rules were implemented in an attempt reduce the amount of errors. Fasting before the experiment was an attempt to have every subject start on a fairly even playing field even though in reality not all subjects would be able to do so. In appreciation, I enjoyed doing this lab assignment for the reason that I learned how our hormones worked in an entertaining hands-on situation.

Lisa,

Your report is VERY good. A few minor errors here and there. Unfortunately, your hypothesis is stated incorrectly. I mentioned this several times: Which one group will have the highest urine flow rate compared to the other groups. Nevertheless, your results were perfect and your discussion was well written. Good Job.

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REFERENCES