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Abstract

Nature provides several ways of sustaining life, from the familiar consumption and digestion to peculiar parasitism. This study delves into whether humans would be able to survive with photosynthesis, being their only source of energy. We determine that this process would be impossible to provide enough energy on its own, as it would require us to breathe 34 times quicker, in order to inhale the necessary concentration of CO_2.

Introduction

As humans, our daily lives require us to consume food that is then converted into an energy source for our bodies to function. This energy is used for muscle movement and body sustainability within its internal organs, however, this is not the same for plant life; they absorb water and sunlight and convert that into a food source by the process of photosynthesis.

Photosynthesis requires CO_2 and water, as well as sunlight, which acts as a catalyst, to produce glucose and oxygen. This process is shown to be[1]:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2 \qquad (1)$$

where in this reaction, glucose is the main food source of the plant. This paper delves into the question of whether or not we, as humans, are able to maintain our daily lives with photosynthesis as the only energy source.

Theory

To calculate if photosynthesis is viable for our bodies; the amount of energy required to function per unit time is known as the basal metabolic rate. If an average male, with an average mass M is used as an example, the formula for basal metabolic rate for mammals is [2]:

$$BMR = 0.74M^{0.55} \qquad (2)$$

This can be used to calculate our daily requirements, in mega-joules per day. If converted into joules per second and compared to the amount of energy released from the breakdown of glucose, which is found to be 2.87 $\mathrm{MJmol^{-1}}$[3], therefore the total moles of glucose per second required to function can be obtained. This is making the assumption that we are able to live solely on glucose alone. From Equation 1, the ratio between the amount of carbon dioxide needed to produce one mole of glucose is 6:1, respectively.

Plants use leaves as a way of absorbing sunlight; we can assume we do the same except that the sunlight can be absorbed through the skin. Since the human body is mostly composed of water, the only product that needs to be found is the CO_2. We can determine the amount of CO_2

needed by calculating the moles accumulated per breath. This can be done by calculating the mass of CO_2 in a single breath, and then using the definition of the molar mass:

$$n = \frac{m}{M_r} \tag{3}$$

where n is the moles, m is the mass of CO_2 and M_r is the molar mass of CO_2 (44 gmol^{-1}). This gives us our concentration of CO_2 per breath, which we can compare to the previously discussed value of required CO_2 for sustainable living to show if photosynthesis is viable for humans.

Results

We assumed an average male would weigh 70 kg, which when applied to Equation 2 and converting from 'joules per day' to 'joules per second', we got a value of 87.38 Js^{-1}. Using the amount of energy per mole released from the breakdown of glucose, the amount of glucose needed to sustain us every second is 3.06×10^{-5} mol. When that was applied to the 6:1 ratio, we found the minimum required moles of CO_2 required per second is 1.84×10^{-4} mol.

To calculate the amount of CO_2 in a single breath, we had to find the mass of one breath. Assuming we breathe once per second, we found that one breath has the mass of 0.6 g[4] of air, which given only 0.04%[5] of the air is CO_2, this gives us a mass of 2.40×10^{-4} g for CO_2. This mass can then be used in Equation 3, where we obtained the moles of CO_2 per breath to be 5.45×10^{-6} mol.

Conclusion

From calculating the amount of CO_2 we get in a single breath and comparing it to what is needed to sustain the glucose production required for humans to function. We can see that the concentration of CO_2 needed to sustain our bodies is 34 times greater than what we are capable of inhaling in a single breath. This means naturally we would not be able to survive off photosynthesis alone, as we would either need an extra source of energy or we would to be required to breathe 34 times per second.

This theory is based on the thought of us surviving with sugar as our only food source; however other food groups are also included in a typical diet giving room for more energy to be acquired. Looking into the external consumption of food along with the process of photosynthesis, as well as including a more active person's metabolism, would be required for a more accurate look into the proposed scenario.

References

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