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In One Piece what causes the Devil Fruit users to be immobile when immersed in water?

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Abstract

This paper explores two reasons why characters in the anime *One Piece* are rendered unconscious when submerged in a body of water. The 'Devil Fruit' is an ingested substance that gives supernatural powers but also an apparent immobility in water. This paper theorises that the phenomenon caused by the 'Devil Fruit' may be attributed to mutations in the mechanoreceptors that regulate tolerance to water pressure. Alternatively, characters begin to claw at their throats before fully submerged suggesting a narrowing of the airways, symptoms commonly observed during anaphylaxis (allergic reactions). The 'Devil Fruit' may therefore cause mutations that render filaggrin, a gene central to the monitoring of inflammation and thus allergic reactions, non-functional.

Introduction

One Piece is an anime that is based on pirates exploring the Sea to find a stash of gold known as the 'One Piece'. Some pirates display superhuman abilities after eating a magical fruit called the 'Devil Fruit'; the super power depends on the fruit that has been consumed. After accidentally eating a 'Devil Fruit', Luffy, the protagonist, gains properties of elasticity as his body changes to be made of rubber. However, the downside to all Devil Fruit users is that they become immobile in water when fully immersed as the 'Devil Fruits' are considered a curse [1].

In water Devil Fruit users become extremely lethargic, sleepy, immobile and eventually, if under for too long, unconscious. They display similar properties to that seen in Superman when he encounters kryptonite [2]. For the 'Devil Fruit' to cause such drastic changes within the body alterations in the DNA must be made. This paper explores possible locations of biological mutations that may have occurred to cause Devil Fruit users to become powerless in water. It should be noted that water is not the only weakness of Devil Fruit users but is what this paper will focus on.

Pressure receptors

Water has an increased density in comparison to air, thus pressure applied on the body underwater is

greater [3]. The further down the individual is in the body of water the greater the applied pressure. The pressure inside the body is influenced by that of the environment outside the body [4]. One of the most dangerous effects of increased pressure is the possibility of lung compression. External sustained pressure is detected by mechanoreceptors, particularly the Pacinian corpuscle [5]. An explanation for weakness underwater observed in Devil Fruit users could be explained by a mutation resulting in a reduced pressure threshold. However, internally the same concept may occur. Increased sensitivity of receptors such as pulmonary stretch receptors will cause a lower tolerance to high external pressures, as the lungs will start to compress at lower pressures. This could explain the difficulty Devil Fruit users have in breathing when in water, as several scenes show them grabbing their chests and throats in agony [1].

To calculate the minimum pressure needed to cause underwater weakness, the height of the fluid above the individual was set at 1 m. This is because there are scenes in the anime where near the surface of the water Devil Fruit users have some movement in the upper body; severity of weakness seems to increase with depth. A depth of 1 m would ensure they are fully submerged in the body of water. This paper assumes that the Devil Fruit user will be in an upright

position when in water with hands by their sides, as seen in many instances in the anime [1]. Therefore, the pressure calculated is the minimum amount of pressure applied on the individual required to trigger complete weakness. There will be different amounts of pressure applied to various parts of the body as each body part is has differing heights of fluid above it, however this paper calculates the pressure threshold (minimum value). The head, being the highest point of the person, will experience the least amount of pressure as it is closest to the water surface.

$$P_{fluid} = \rho gh, \quad (1)$$

where P is the pressure on an object submerged in fluid, g is the acceleration of gravity, h is the height of the fluid above the object and ρ is the density of the fluid.

$$\begin{aligned} P_{total} &= P_{atmosphere} + P_{fluid} \quad (2) \\ P_{fluid} &= (1.03 \times 10^3) \times (9.81) \times (1.00) \\ &= 11104.3 \text{ Nm}^{-2} \\ P_{total} &= 1.01 \times 10^5 + 10094 = 111104.3 \text{ Pa} \end{aligned}$$

The pressure threshold has been identified to be $\sim 111,104$ Pa using equations 1 and 2 [3, 6]; pressures exceeding this would be intolerable for Devil Fruit users and eventually cause immobility. The severity increases with pressure, hence coincides with scenes from the anime where Devil Fruit users at the surface of the water can still move, whereas those deep down are paralyzed [1].

Anaphylaxis

Anaphylaxis occurs due to mutations in signalling proteins and/or receptors. When the body detects a foreign object, in this case water - allergen, it causes the release of histamines, prostaglandin D2 and other preformed mediators [7]. The preformed mediators cause increase bronchoconstriction causing the bronchioles and airways to constrict and inhibit

successful ventilation. Aquagenic Urticaria is a rare condition where an individual develops rashes upon contact with water [8], however this cannot be applied in this scenario as Devil Fruit users are not affected by occasional contact with water. In the show there are multiple scenes that show Devil Fruit users choking and clawing at their necks suggesting a struggle to breath which mimics the responses of individuals in anaphylactic shocks [1].

Diseases such as some cancers arise due to mutagens inducing mutations [9]. This paper therefore proposes that ingestion of the 'Devil Fruit' can cause the entry of a mutagen, into the body that brings about these changes. The gene filaggrin (FLG) has been found to be responsible for allergic diseases such as atopic asthma [10] and is an example of a mutated gene resulting in anaphylaxis. If asthma is left untreated it can cause anaphylaxis [10]. Nonsense mutations cause loss of function in FLG and are considered the culprit of these diseases [10]. Ingesting a 'Devil Fruit' could potentially alter the FLG gene to prevent the production of inflammatory regulators including receptors that are key to the prevention of allergic responses. The toxin found in Devil Fruit users that causes this change must be able to penetrate into the nucleus of the victims' cells to be able to change the proteins/receptors at a genetic level.

Conclusion

The focus of this paper was to explore possible reasons that characters in the anime 'One Piece' became immobilised when fully submerged in water after consumption of 'Devil Fruit'. One cause was suggested to be increased sensitivity in mechanoreceptors resulting in the heightened response increasing water pressures such that lung compression starts to occur at a lower threshold ($\sim 111,104$ Pa). Another cause details the presence of a mutation that affects the FLG gene eliciting an allergic response similar to anaphylaxis.

References

- [1] One Piece (2017) Fuji Network System, RTL II, Korean Broadcasting System.
- [2] MiguelitoLoveless (2007) *Superman Christopher Reeve Defeated by Kryptonite*. YouTube. Available at: <https://www.youtube.com/watch?v=OkSaAhbceBk> [Accessed 6th March 2018]
- [3] Tipler, P. & Mosca, G. (2003) *Physics for Scientists and Engineers, 6th ed.* New York: W.H. Freeman.

- [4] Atlantis-bali-diving.com (2018) *Pressure and Your Body 4*. Scuba Dive – Resources - Atlantis-bali-diving.com. Available at: <https://www.atlantis-bali-diving.com/scuba-dive/pressure-and-your-body-4> [Accessed 7th March 2018]
- [5] Purves, D., Augustine, G.J., Fitzpatrick, D., Katz, L.C., LaManta, A.S., McNamara, J.O. & Williams, S.M. (2001) *Neuroscience: Mechanoreceptors Specialized to Receive Tactile Information, 2nd ed.* Sunderland (MA): Sinauer Associates. eBook available at: <https://www.ncbi.nlm.nih.gov/books/NBK10895/> [Accessed 7th March 2018]
- [6] Hodanbosi, C. & Fairman, J.G. (2016) *Fluids Pressure and Depth*. NASA. Available at: https://www.grc.nasa.gov/www/k-12/WindTunnel/Activities/fluid_pressure.html [Accessed 6th March 2018]
- [7] Peavy, R.D. & Metcalfe, D.D. (2008) *Understanding the mechanisms of anaphylaxis*. *Current Opinion in Allergy and Clinical Immunology*, 8(4), pp 310–315. DOI: 10.1097/ACI.0b013e3283036a90
- [8] Hoon Park, M.D., Hee Su Kim, M.D., Dong Soo Yoo, M.D., Jin Woo Kim, M.D., Chul Woo Kim, M.D., Sang Seok Kim, M.D., Jong Ik Hwang, M.D., Jun Young Lee, M.D., & Yoon Jeong Choi, M.D. (2011) *Aquagenic Urticaria: A Report of Two Cases*. *Annals of Dermatology* 23 (3), S371–S374. DOI: 10.5021/ad.2011.23.S3.S371
- [9] Parsa, N. (2012) *Environmental Factors Inducing Human Cancers*. *Iranian Journal of Public Health*. 41(11), pp 1-9.
- [10] Ogradowczyk, A., Markiewicz, L. & Wróblewska, B. (2014) *Mutations in the filaggrin gene and food allergy*. *Gastroenterology Review*, 4, pp.200-207. DOI: 10.5114/pg.2014.45100