**Does the introduction of the GR2E trait into rice increase the concentration of carotenoids?**

**Claim**

Genetic engineering has revolutionised agriculture

**Research Question**

Does the introduction of the GR2E trait into rice increase the concentration of carotenoids?

**Evidence**

The research article *Compositional Analysis of Genetically Engineered GR2E “Golden Rice” in Comparison to That of Conventional Rice* was published in 2019 in the Journal of Agricultural and Food Chemistry. The study investigates the nutritional content found in GR2E rice compared to regular rice. The study collected rice samples from four sites in the Philippines in both the wet and dry season. These samples were then crushed and through a lengthy chemical process the concentration of carotenoids in the samples was determined.

Table 1: Concentrations of, Carotenoids in Grain Samples Derived from GR2E and Control Rice (Swamy et al., 2019)

|  |  |  |  |
| --- | --- | --- | --- |
|  | GR2E | | control |
| component | mean | range | mean |
| Carotenoids (mg/kg DB) | | | |
| β-cryptoxanthin | 0.31 | (0.23–0.46) | *<*[LOQ](https://pubs.acs.org/doi/10.1021/acs.jafc.9b01524#tbl5-fn1) |
| *all*-*trans*-α-carotene | 0.71 | (0.35–1.32) | *<*LOQ |
| *all*-*trans*-β-carotene | 3.57 | (1.96–7.31) | *<*LOQ |
| 9′-*cis*-β-carotene | 0.76 | (0.5–1.32) | *<*LOQ |
| total carotenoids | 5.88 | (3.5–10.9) | *<*LOQ |

LOQ=Limit of Quantification

Table 1 shows the results of the study and lists the concentration of carotenoids found in rice samples. These concentrations show that the presence of the GR2E trait is causing an increase in all carotenoids from below the level of quantification to a significant amount. It also shows the amount of each type of carotenoids, with trans-beta-carotene being the most prevalent and comprising the majority of carotenoids in the BR2E rice and beta cryptoxanthin being in a small concentration.

The results in Table 1 occur are due to the gene which was transferred to the rice via genetic engineering processes to create a transgenic specious of rice with altered nutritional properties. The genes were transferred from a species of maize and bacteria which together creates plants which produce carotenoids, a molecule which the body converts to vitamin A. The genetic engineering process which was used to insert the genes into the rice was Agrobacterium-mediated transformation (Baranski, 2022). This process involves injecting genetically modified bacteria with the intended gene into the plant embryos, which alter the rice’s genome. It is then tested to see whether these genes have the desired effect and pass their trait onto the next generation.

The studies data has very few limitations. It is a recent study which uses a public method which has supporting citations. One of these few limitations is that the rice analysed was uncooked. Since cooking is known to decrease the number of carotenoids in the rice, this means that the scientists adjusted the number of carotenoids by 20% which may not be exact to reality as cooking methods vary throughout society. Another limitation is that of the differing maturity of the sample plants, which was said to be during harvesting season but does not take into account the plant maturity difference between the beginning and end of harvesting season. A third limitation is the geographical location of the rice samples, which were all taken in The Philippines. This means that the data only takes into the account rice grown in the climate and soil quality of The Philippines, which may change the nutritional composition. Although these limitations are apparent, even if these were rectified with a more thorough study, this would likely only have a slight difference on the final nutritional content.

**Conclusion**

The data proves the research question correct by showing a clear increase of carotenoids between the genetically modified GR2E rice and the control rice. Although this data is clear in its findings, it still had some limitations which may alter the actual carotenoid intake of humans including soil quality, geographical location, cooking method and season. This investigation could be improved by using multiple scientific studies which verify its findings; however, it is clear even without other citations that GR2E rice contains higher concentrations of carotenoids.

**Evaluation**

The data shows that Agriculture was indeed revolutionised by the use of genetic engineering. Since people have solved vitamin A deficiency in some countries by modifying the genome of the rice those people eat is very revolutionary. Some other examples of genetic engineering revolutionising agriculture that could be investigated include wheat growth modification and various crops being genetically modified for disease immunity and pest protection.

**Reference List**

Swamy, B., Samia, M., Boncodin, R., Marundan, S., Rebong, D., & Ordonio, R. et al. (2019). Compositional Analysis of Genetically Engineered GR2E “Golden Rice” in Comparison to That of Conventional Rice. *Journal Of Agricultural And Food Chemistry*, *67*(28), 7986-7994. https://doi.org/10.1021/acs.jafc.9b01524

Baranski, M. (2022). *Golden Rice*. Embryo.asu.edu. https://embryo.asu.edu/pages/golden-rice.