our future through science

Sorghum Biotechnology for Food and Health

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The goal of this project is to develop transgenic sorghum varieties that will deliver essential amino acids; lysine, threonine and tryptophan; vitamins A and E; iron; and zinc which are deficient in sorghum to African populations in the arid and semi-arid tropics. Taking cognizance of the limitations of classical breeding in the area of nutrition in fortifying sorghum with these essential amino acids, vitamins and minerals, our strategy will rely on genetic engineering. Additionally, the sorghum will increase caloric uptake as a result of improved grain product digestibility. We refer to the end product as African Bio-fortified Sorghum (ABS). Development of the new varieties of staple sorghum food plants will aid in improving nutrition and human health. Sorghum has been selected for this project because it grows and reproduces reliably in the arid and semi-arid ecological zones of Africa. It is the staple food for most people in communities that cannot afford rice or in areas where maize does not grow and reproduce well. Consideration of the fact that sorghum has an inferior nutritional profile triggerred a formidable partnership that includes: Africa Harvest, for general co-ordination, public acceptance and communication; AATF, for IP brokering and licensing; ICRISAT, for germplasm and field studies; Pioneer/DuPont and the CSIR for technology development; University of Pretoria for product development; ARC Potchestroom for breeding and field studies; and FARA for pilot scale distribution. The project is being funded by the Bill and Melinda Gates Foundation. This poster presentation describes initial laboratory research geared towards the objectives of the project.

LIGHT AT THE END OF A TUNNEL: A SORGHUM THAT DELIVERS IT ALL

Cell systems, notably of plant origin and selectively of animal origin (including stem cells) exhibit competency for totipotency and developmental morphogenetic plasticity. Through hormonal manipulation, we can direct and map cell fate in these systems to achieve targeted terminal end-point developmental differentiation into cell lines, tissues, organs, organism, etc. We use selected *Agrobacterium* vectors, bearing nutritional genes, to infect sorghum embryos (**Figure 1**) and subsequently derive transgenic embryogenic callus (**Figure 2**).

To ensure that we use optimum conditions for our transformation and that the genes we use are functional, we use two marker genes, *uid*A encoding GUS, whose activity can be verified by blue colouration in a typical assay (**Figure 3**) and a gene encoding a green fluorescent protein, GFP (**Figure 4**).

Apart from providing proof that target cells for transformation have taken up foreign DNA, progression in the transformation process can be continually monitored as shown in **Figure 5**. Tissues shown in **Figure 4**, after an initial burst in expression of GFP may lose most of the expression as shown by the fewer green cells (**Figure 5**) because most of the expression in Figure 4 was transient. At this point, hope would seem to fade.

Eventually, and after subjection to several rounds of selection, the fewer cells in **Figure 5** will grow, multiply and form a huge mass of callus all stably expressing GFP (**Figure 6**). The bigger the mass of GFP expressing cells, the bigger the light, "at the end of the tunnel". One day soon, and through this systematic transformation process we will have a sorghum crop that delivers it all; essential amino acids; lysine, threonine, methionine and tryptophan; vitamins A and E, iron and zinc, you name it!

CONCLUSION

In conclusion, our pledge is that we will utilise all the knowledge generated from sorghum's closest relatives; maize, rice, wheat and barley, and our skills in molecular biology, genetics and transformation technology to produce a sorghum that delivers all our promises without compromising the yield, grain quality and product safety. We believe that we will make critically important contributions, not only to food security in Africa, but also to the economics and nutrition of poor families and children affected by HIV/AIDS, malaria, diarrhoea and other ailments common in Africa.

Figure 1.

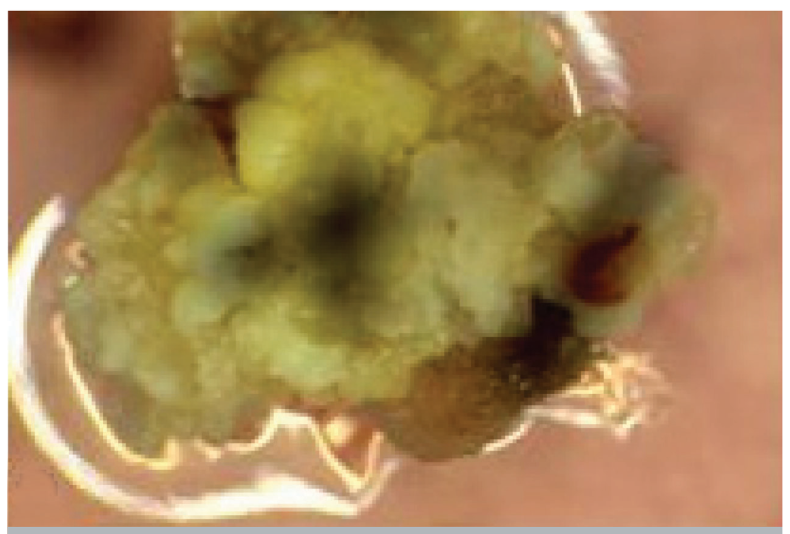

Figure 2.

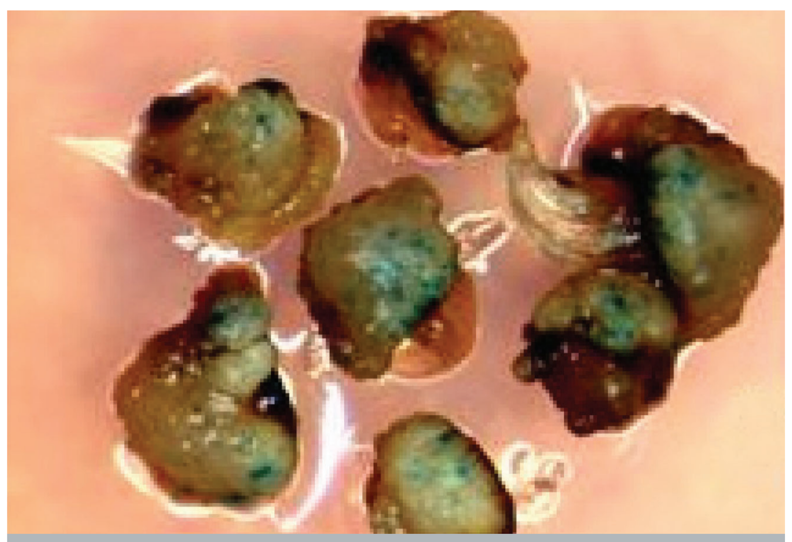

Figure 3.

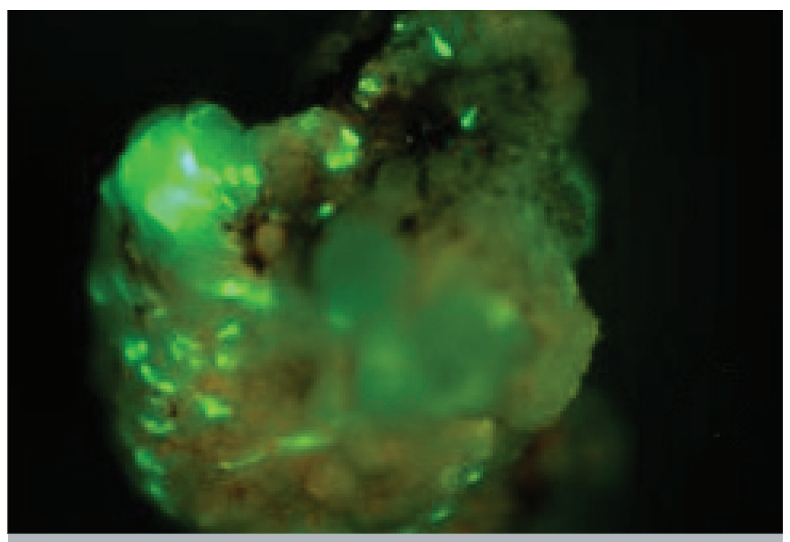

Figure 4.

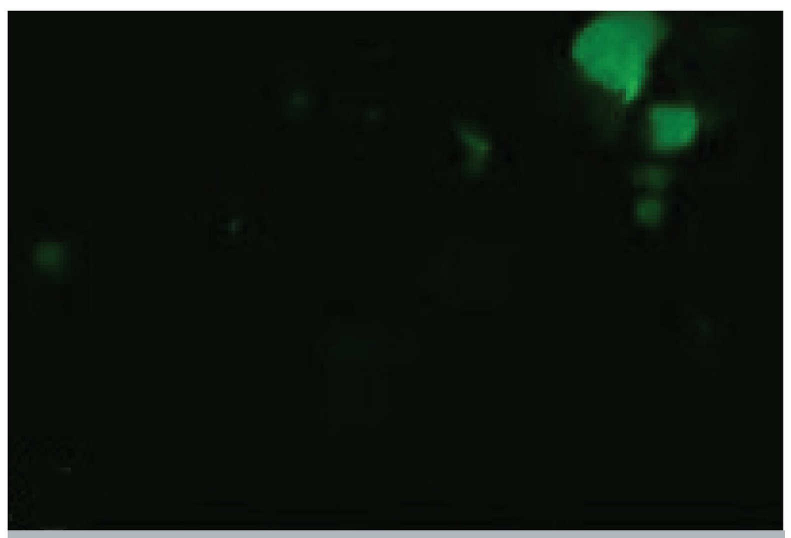

Figure 5.

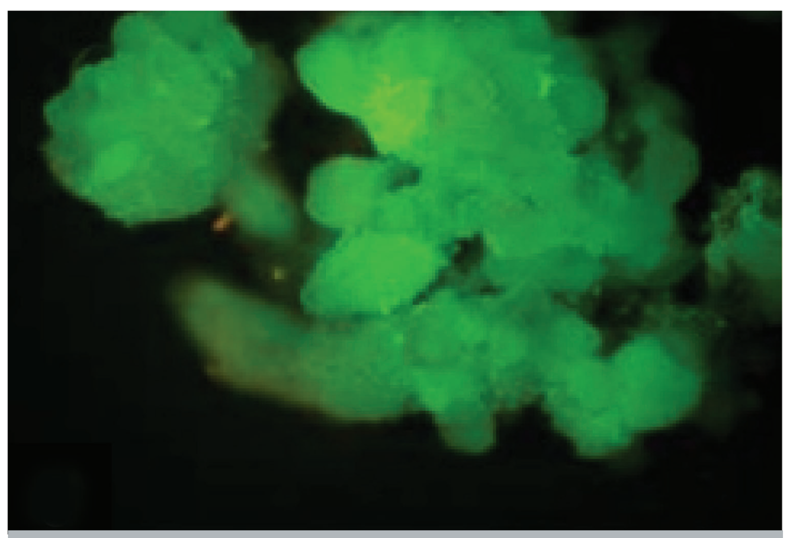

Figure 6.

For many of the world's most food insecure people, sorghum (*Sorghum bicolor*) is the primary food grain. It is one of the most important staple crops in Africa and is uniquely adapted to the semi-arid and sub-tropical climatic conditions of the continent.

CSIR scientist, Andile Grootboom, working with sorghum in a greenhouse in South Africa.

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