ENHANCED PROTEIN CONTENT AND QUALITY IN SWEETPOTATO ENGINEERED WITH A SYNTHETIC STORAGE PROTEIN GENE FOR IMPROVED HUMAN NUTRITION AND HEALTH

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It is essential that human diets are endowed with those amino acids that the body cannot synthesize (essential amino acids, EAA) and nitrogen in the form of non-essential amino acids (NEAA). Both EAA and NEAA are required for the biosynthesis of protein and other nitrogen-compounds vital for homeostasis and human growth. Thus the quality of a food crop protein is of considerable importance to crop improvement. We sought to improve the nutritive quality of **sweetpotato** proteins, a NASA candidate crop, by enhancing its 'essential amino acids' (EAA) content. A novel storage protein (*asp-1*) rich in many EAA and with improved protein stability was rationally developed. The synthetic *asp-1* gene under the control of CaMV 35S promoter was introduced into sweetpotato (*Ipomoea batatas* L) using the *Agrobacterium* gene transfer system. Transgenic sweetpotato plants grew normally in a field trial, and in an unanticipated twist, showed 300 - 500% increase in the total protein content in their storage roots ('tuber'). Levels of many EAA such as methionine, threonine, isoleucine, and lysine also increased proportionally, while tryptophan increased by several orders of magnitude. Although transgenic plants expressed the *asp-1* protein detectable by immunoblot analysis, the increased protein content in the roots was primarily due to enhanced levels of several native proteins, especially sporamin and ß-amylase. The increase in protein as well as EAA levels in transgenics remained steady over a period of three field trials. Protein accumulation in the transgenic plants follows a temporal fashion in a time course study. The yields of two transgenic lines were comparable to that of control plants while the other three lines exhibited yield penalty. Animals (golden Syrian hamsters) fed with transgenic sweetpotato had 56% more live body weight over the control-fed animals and exhibited lowered total cholesterol, triglycerides, and LDL-cholesterol levels in their plasma and liver. The animal feeding also showed the superiority of *asp-1* sweetpotatoes in terms of the true protein digestibility, nets protein utilization and biological value of the protein. The corrected 'protein efficiency ratio' of transgenic sweetpotato (3.71) was comparable to that of soy protein (3.72) and higher than control sweetpotato (2.57) or casein (2.49). The animal histopathological studies with brain, liver, kidney, intestine, and bone showed that transgenic sweetpotato lines did not have any detectable toxic effects. Our research now is testing various hypotheses for the causes of dramatic increase in the total protein content in sweetpotato transformed with the *asp-1* gene. ***Research supported by NASA and USDA***.