

Synthetic carbohydrates for food

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Since the inception of agriculture by mankind about ten millennia ago, the basis of the food supply for the human population has been the farming of field crops. However, our conventional, biogenic agriculture (CBA) has failed to provide a reliable concept to feed a growing population in a sustainable way. In particular CBA suffers from severe environmental externalities - such as the massive use of land area, water for irrigation, fertiliser, pesticides, herbicides, and fossil fuel.

Here we suggest the artificial synthesis of carbohydrates from (atmospheric) carbon dioxide (CO₂), water, and renewable energy. This approach would allow not only a highly reliable production without those externalities, but would also open the possibility to increase the agricultural capacity of our planet by several orders of magnitude. Our study shows that saccharose could be produced from CO₂, water and electrical energy with an efficiency exceeding 30%, or about 15 kWh per kg of sugar. Factoring in the efficiency of photovoltaic electricity generation we derive a „sun to sugar“ efficiency exceeding 6%, which is about 10-times the efficiency of CBA sugar beets or sugar cane.

All required technology is either commercially available or at least developed on a lab-scale. No directed research has, however, yet been conducted towards an industry-scale carbohydrate synthesis because the CBA carbohydrate production was thought to be cheaper. In fact we estimate the production costs of artificial sugar at about 1 €/kg while today's spot market price for conventional sugar is about 0.3 €/kg. However, considering the environmental and socioeconomic externalities of the conventional sugar production, its total costs (including external costs) is estimated at 1 to 2 €/kg. Accordingly, artificial sugar appears already today to be the less expensive way of production.

Artificial sugar production allows also subsequent synthesis of other carbohydrates such as starch. Artificial carbohydrate production (vegan+) could provide an affordable and secure food supply for today's world population, drastically lower the ecological externalities of the food system, and free valuable land for alternative use like nature reservations or afforestation.

Of course, replacing part of our agricultural system by industrial production of food can have profound societal implications the discussion of which should be started now.