Up on the Farm: The Role of Vegetables in Conquering Space

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> Having a good meal is, of course, something more than downing one's food. It's a complicated process combining physiological and psychological elements. Even in a short flight tasty, favourite dishes can provide the astronauts with relaxation during their strenuous work. Indeed, not only the taste of the food is important, but even the circumstances in which it is eaten. A spotless table-cloth, attractive plates, pleasant music, and enjoyable conversation help a person to rest while eating, whereas tasteless and unappetizing dishes, and even an unattractively laid table, can cause irritation and, far from being conducive to enjoying a meal, can retard the secretion of digestive juices.[1]

Yuri Gagarin had a clear opinion on the importance of food for astronauts and cosmonauts, and a glorious vision of how food and eating in space should be experienced. Sadly, the realities of space travel, especially during the 1960s and 1970s, proved to be a less savoury experience than he had foreseen.

Vegetable provision on the space menu helps us trace a change in attitude toward space food, in particular in the United States. Through vegetables we can trace a discernible shift in the accepted cultural norms, from the 1960s idea that space heroes really only eat meat; through the 1970s and 1980s where space colonists and people on space stations were expected to demand meat with some vegetables on the side; to the notion in the 1990s and early 2000s that long-term space travellers may need to be self-sufficient and largely vegetarian.

Regardless of the menu it is worth considering what it is really like in space, and how this affects health, appetite, and eating. Between 44 and 67 per cent of space travellers suffer from the loss of appetite, vomiting, nausea, and stomach awareness induced by space motion sickness or SMS.[2] Significant shifts of fluid to the head impact the senses of smell and taste.[3] Muscles and bones atrophy, the effect reduced but not stopped by the considerable effort of resistance training in the challenging conditions of microgravity. There is a risk of cardiac arrhythmia and near certainty of cardiovascular de-conditioning; red blood cells are lost; and exposure to high levels of radiation increases the propensity to develop cataracts in later life as well as increase the chances of developing other radiation-related diseases such as cancer.[4] Digestion isn't easy; flatulence an occupational hazard.[5] Conditions are cramped and stuffy but you can't ever open a window. In astonishingly stressful circumstances crews not only have

to keep the vessel afloat and face the dangerous journey back through the Earth's fiery atmosphere to a safe landing; they have to do their real job whilst there, conducting complex experiments to tight deadlines.

Put yourself in that situation and consider your dinner. How would you feel about food? What would you want to eat, if you could face it at all? Something light; easily digestible; stimulating to the eye; fresh and colourful? Or some comfort food, stodgy and familiar?

In the early years of space exploration it was not consideration of appetite but the approach taken to provisioning that had the strongest impact on the menu. Both the USSR and the USA adopted technologies originally developed for high-altitude pilots – the origin of now infamous tubes of puréed foods, frequently fruits or vegetables. Beyond this, though, the approach between the two nations diverged, for cultural as well as practical reasons, reflected in their attitude to vegetables.

The USSR tended to work with existing technologies, using canned foods (such as potatoes and other vegetables) and dried foods (such as vegetable soups like borsch). This practical approach not only ensured that much of the food taken into space was immediately recognizable as food to the cosmonauts, and might even be the same as some of what they ate at home; it also meant that many more specific vegetables, like beans or mushrooms, were made available in forms other than purées, incidental ingredients in meat dishes, or soups.

The Soviets had started their programme with a clear intention to establish long term habitation in space – their first inhabited space station was launched in 1971 – and the planners took into account psychological factors, including food and eating, much earlier than their US counterparts. A table for eating as well as working was provided on board Mir in recognition of the importance of conviviality. This recognition of the psychological importance of food and in particular vegetables extended to the experiments conducted on board the space station. The beneficial effect of watching plants grow was noted: 'It turned out that watching a plant grow in space was therapeutic, even for cosmonauts with no previous interest in horticulture.'[6] The plants in question also provided a ready and eagerly seized upon source of fresh food. Onions and radishes were frequently grown experimentally, and on several occasions the crew found the crop irresistible and ate it. Sometimes a celebration provided the excuse: 'Sevastyanov's 40th birthday was on 8 July, and Klimuk's 33rd occurred two days later. They celebrated with a feast of spring onions which had grown in the Oasis [the plant propagation unit].'[7] Sometimes these fresh feasts were authorized, as during a long mission in 1987: 'As a special treat, the cosmonauts were told that they could eat the radishes and onions that they had grown.'[8] Occasionally, human greed took over and the arrival of fresh pants was too much for the crew: 'Progress 14 docked on 12 July. It delivered miniature onions for the cultivator, but they were so tempting that they were eaten instead.'[9] Whatever the circumstances, the urge to consume fresh, strongly flavoured vegetation after months in space eating the blander food from packages and cans was too strong to deny.

For the US space programme, at least in the initial stages, food was wrapped into the great futuristic technological drive that the entire programme represented, often with unfortunate results. There was an obsession with the amount of space available to store anything, particularly food: what it would weigh; how long it would take to prepare; how much waste there would be. There was also coy reference to the undesirable digestive effects of pulses and too much fibre. The astronauts' priority was to work, and food and its transport through the body were an inconvenience: the administrators expected astronauts to treat journeys into space as camping trips, and to tolerate the many discomforts involved, including the poor food.[10] Cubes coated in various gums that would dissolve in saliva in the mouth to deliver a taste of toast and butter or fruit cake were developed, and eventually abandoned when they gave astronauts stomach upsets. No thought was given to how revolting it might be to have only cold water to rehydrate dried foods: one of Gemini's major discoveries was that astronauts don't like cold potatoes.[11] Early freeze drying techniques had other unpleasant effects. Oxygen left in the voids of the food can lead to oxidation, causing browning and deterioration, particularly in caretenoids. 'Carrots are especially susceptible to loss of color, loss of flavour and the development of "perfume-like" odor. Other vegetables develop a "hay-like" odor as a result of oxidation.'[12] None of these effects made the consumption of vegetables more appealing, and probably ensured that they remained in a minor role. They appeared in the diet as less important stew ingredients or as a small side dish for a meat main course, not as main dishes in their own right.

Although it was several years before any significant complaints were made, it became clear that the diet of Gemini and Apollo during the late 1960s was leaving astronauts dissatisfied. They lost weight, and they returned to Earth with far more uneaten food that they should have done. Still more worrying, they were not consuming the required nutrients. Food therefore became a major focus for the US programme for the first time when Skylab went into operation in the 1970s. Not only did the space station have a kind of dining area (designed by Raymond Loewy) leading to more structured meals and meal-times; the astronauts' food consumption was closely monitored and they were actually forced to eat their meals as required by the nutritionists. Although these crews were the first not to lose weight in space this wasn't always popular. Vegetables, which became a key menu item monitored from earth, came in for particular criticism. 'I found that if I reconstituted the peas, the beans, and the asparagus early, and then reheated them,' Pete Conrad quipped, 'I still didn't like them, but they were a lot easier to choke down than when I added the hot water, shook up the bag and then tried to get them down.'[13] The problems were compounded by an issue with the water pressurization system, which meant it was full of air bubbles, so that the astronauts could not help ingesting excessive air with their rehydrated food, leading inevitably to flatulence. As one astronaut commented, 'Farting about 500 times a day is not a way to go.'[14]

Matching the urges of the onion- and radish-eating cosmonauts, fresh vegetables featured as an important element in astronaut fantasies about homecoming. It could

be argued that this reflects a natural craving for variety in both texture and flavour, as well as a desire for freshness. The sense of taste is affected by space travel, and almost all astronauts and cosmonauts develop a preference for strong condiments to enhance their food – for Russians garlic and for Americans chilli sauce. In a series of letters home from Mir Jerry Lineger puts 'a big, fresh salad' in the top four items for his first meal when he arrives home, adding, 'To be honest, anything would be fine, even John's baby food leftovers, as long as it doesn't come in a tube!'[15] Despite the technical team's feeling that space heroes would want and need protein in the form of meat, the experience of many of the crew members bears out the idea that more variety, more flavour and, in particular, more vegetables, whether whole or as flavour-enhancing garnish, were actually welcome.

Whilst reality unfolded on Skylab and Mir during the 1970s and early 1980s, another group of scientists was working in parallel on the practicalities of establishing space colonies. Some saw such extra-terrestrial escape as the obvious, even inevitable, next step for humankind, having exhausted and over-populated the earth. Several physicists' ideas (e.g. Dyson, Bernal) were developed into working designs for huge space stations that could support significant human communities. They would use the power of a star or the sun to remain in space and to support the energy needs of the population living, working, and farming inside. Solar reflection panels would move to simulate day and night for crop growth, and CO_2 condensers would ensure a plentiful supply of water. The descriptions and in particular the illustrations of these space communities are striking for their focus on green spaces for leisure as well as farming. Many interior views show green fields and countryside stretching out as far as the eye can see into the depths of the spheres, as well as more detailed proposals for mixed farm complexes that include extensive fields of grains, pulses, and vegetables.[16]

Nonetheless, the meat focus noticeable in the planning for the early space missions remained apparent in the overall planning of the food supply for these putative space colonies of the 1980s. One of the cited benefits of growing vegetables and grain hydroponically (where plants are grown through holes in Styrofoam boards, roots suspended in a nutrient-rich water solution) was that 'the roots could be harvested for animal feed.'[17] Although plant growing was seen as an essential component of the diet, meat, fish, and eggs were all assumed to be required for the health and, in particular, the contentment of the colonists: 'The colonists will want to eat meat.'[18] The focus was on being as efficient about it as possible. Rabbits, goats (for milk as well as meat), and chickens (for eggs as well as meat) were all proposed as ideal food animals, and an argument for the possibility of supporting a small herd of Hereford or other beef cattle was even put forward.[19] Although it was acknowledged that 'cattle are rather wasteful at converting feed to beef,' the overriding concern was that 'people like to eat beef.'[20] Growing plants for animal consumption and managing the additional smells and CO_2 build-up appear to have been considered prices worth paying to ensure as little change as possible to a meat-focused Western diet.

The change in cultural expectations in the intervening decades is notable. Since the later 1980s and the introduction of the space shuttle, more fresh salad vegetables have been included in the food provisions, made possible by a small fridge and the use of irradiation to give longer life to fresh food. Changing diet expectations are also naturally reflected in the food plans for future space travel, in particular the ongoing investigation into the possibility of a manned trip to Mars. A mission to Mars would take at least two years, and could not be re-supplied en route (in contrast to the now-retired Mir and the current International Space Station [ISS], both in accessible orbit above Earth). Neither is it practical to provide room for the bulk and weight of two years' worth of provisions for a probable crew of six. Self-sufficiency is therefore required. The crew must be able to grow, process, cook, and consume food during both the outward and return journeys, and when they land on Mars. This requirement automatically gives hydroponically grown vegetables a starring role. ESA, the European Space Agency, expects 40 per cent of the diet to be grown and processed on board, the main crops being rice, onions, tomatoes, soya, potatoes, lettuce, spinach, wheat, and spirulina.[21] Indeed, meat has been dropped as a practical consideration, at least as a live commodity that could practically be supported and farmed en route and on arrival. The earth-bound debates on the energy required to raise meat for human consumption take on a new urgency and come to a speedier and more obvious conclusion when one is actually faced with the possibility of a crew of humans in confined conditions having to compete with their own dinner ingredients for the basic resources – water, air, food – needed for all of their survival.

Since the beginning of manned space programmes the conditions aboard spacecraft have made it almost impossible to replicate the food and eating experiences that the men and women involved would have on earth. The approach taken has been limited as much by cultural factors as by technical constraints. Historically, vegetables in space have reflected the cultural norms in US and Russian society; as side dish and minor ingredient in the former and soup ingredient and raw garnish in the other. Initially constrained by technology that processed them into often inedible and indigestible forms, vegetables are now poised to take a leading role in the future of space eating. Perhaps a love of vegetables will eventually become a new qualification for astronaut selection, at least for long-term missions.

Notes

1. Gagarin and Lebedev, 27.
2. Kanas and Manzey, 17.
3. In 1978 the USSR conducted the Opros questionnaire on board Salyut to help psychologists correlate physical and mental health; sense of smell was considered an important enough factor in the psychological condition of cosmonauts to be included with analysis of eating and sleeping habits. See Harland, 65; Rappole, 17.
4. See Compton and Benson; Lane and Schoeller; Sauer, ed.

5. Crouch, 58.
6. Harland, 343.
7. Harland, 42.
8. Harland, 150.
9. Harland, 101.
10. Sauer, ed., 20.
11. Hollender, 9.
12. Hollender, Klicka, and Smith, 272, 275.
13. Crouch, 246.
14. Crouch, 244.
15. Lineger, 201.
16. Web searches for Bernal or Dyson spheres readily bring up some of these illustrations. See also Heppenheimer; O'Leary.
17. Heppenheimer, 126.
18. Heppenheimer, 126.
19. Heppenheimer, 126–128.
20. Heppeneheimer, 128.
21. 'Dinner on Mars: How to cook Martian bread', at http://www.physorg.com/news4495.html.

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