Chronicle of Aquatic Science
https://chronicleofaquaticscience.in/

Chronicle of Aquatic Science
Open Access Peer Reviewed Journal
Vol. 1, Issue 7

Review Article
Pramanik et al. (2023)
Manuscript Id: CoAS_V1IS7_01

OPEN ACCESS

The Utilisation of Space Foods and Their Detriments: An Extensive Review

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(Received- 03.11.2023, Revised- 18.11.2023, Accepted- 27.11.2023, Published: 04.12.2023)

How to cite this article:

Pramanik, P. and Tewari, S. 2023. The Utilisation of Space Foods and Their Detriments: An Extensive Review. *Chronicle of Aquatic Science* 1(7): 1-9.

ABSTRACT

Space foods are regarded as a type of foods which are created and processed for imbibing by Astronauts throughout the small or protracted mission to exterior space. People are very much closely associated into spacecraft which having a human crew before few many years, along with International Space Stations while the foremost terminus for short- or long-term missions. To search out widely the suitable avenue for Astronauts to carry on adequate food consumption in time of longest life at Moon or Mars. Furthermore, for little or big mission, longer shelf life containing foods are suitable which must be nutrient denser. Space foods are affected by microgravity, DNA destruction, hamper metabolism, intestinal distress and so on. Space foods are classified as canned foods, dehydrated foods, medium moisture foods, natural foods, refrigerated foods, fresh foods, irradiated foods, and functional foods. first five denoted space foods are utilised in squat missions broadly however remained three space foods are employed in space flights or prolonged missions. space foods have also some provocations which create hazards for Astronauts including quick lost the shelf life in fresh foods, no standardization, insufficiency in cooking and storage, diet menu fatigue. This review proclaims about space foods and its snugness on Astronauts.

KEYWORDS

Astronauts, space foods, diet menu fatigue, small or large mission, drawback of space foods.

Introduction

People are very much habituated to spent along with International Space Station (ISS) for small or brief missions **(Witze, 2016).** Authors have reviewed that, prolonged secluded missions for 8 months regarded as Hawaii Space Exploration Analogue and Stimulation (HI-SEAS) III journey, this recent research have done by the National Aeronautics and Space Administration (NASA) associates in investigation and remodelling of space at HI-SEAS domain. In time of expanded mission, functional food components are very much needed for space person **(Anderson *et al.*, 2016).** On the other hand, for small timed mission, Astronauts accept minimal shelf-life included food items while long termed mission always required wide shelf life including food products **(Grimm *et al.*, 2016).** Due to exchange of food constituents among tastes, nutrition, storing capability, packaging contemplation, the minimum taste of processing spaced food items may be caused of fatigueness of menu. Besides adequately refined space food item caries much more nutrients which are needed to assist space person for ameliorating the osteoporosis **(Stein, 2013)**, atrophy in muscular region, cardiovascular complications, insularity in the upper elementary system and another physio-chemical alteration **(Zhu *et al.*, 2019).** According to literature review, utilisation of freeze-dried food constituents is totally restricted and also band the consumption of unprocessed food items as natural and fresh foods are very much brittle microbiologically therefore creates biasness to search out the required latrine in entire expedition at space station **(Anderson *et al.*, 2016).** Authors have revealed that, freeze drying foods have no implication on psychiatric health. Furthermore, raw food items can keep up the good mental well-being of Astronauts **(Anderson *et al.*, 2016).** Packed food constituents are not sensible for prolonged space journey because there are needed sufficient lighting, provision of agriculture, greenhouse gas adequacy to formularize the original space food items.

The advancement of space foods

In prior 1960s, space foods have focal point on nutritious, calorie reached, tasty food compounds which have no provision for storing foods in space aircrafts in small timing missions. Furthermore, American, Russian space person drop their weight by intake aluminium tube packet containing foods like chopped meat, jam and another paste food items, simultaneously, bite sizable food cubes have excessive calorie consists of protein, fat, sugar, fruit, and nuts. These space food compounds are very much nutritive, microbiologically safe however cosmonauts undergo menu fatigue. The space expedition is very much wider from middle of 1960s to first 1970s simultaneously enhanced the better quality, diversity, prolonged shelf-life conditions for storing compounds in cans, bars and retaliate pouches **(Perchonok & Bourland, 2002).** Food consumption from unlidded vessel along with apparatus that enhances conceivable at initial period because rehydrated food items are very much pronounced in space food categories through the lots quantity of water from abundantly utilisation of hydrogen and oxygen fuel. Dehydrated food items decrease the storing capacity and required power at keep down the necessity for food storing at freeze **(Perchonok & Bourland, 2002).** In recent decades, the advancement of space foods, refrigerating storage, heating procedures space ship have observed by the utilisation of thermal stabilised bags, fruit in cans, irradiated meat products, freeze dried food constituents. The food compounds in space should be hygienically safe and secure, nutritious, suitable, and acceptable.

Classification of Space foods

In accordance with **Bergouignan *et al.*, 2016**, Space foods are classified as canned foods, dehydrated foods, medium moisture containing foods, natural foods, refrigerated foods, fresh foods, irradiated foods and also functional foods. the earliest five type of food items are extensively utilised and proportionally developed in case of mini space journey besides preceding three type of food items are very much accepted to full fill the requirement of prolonged space journey. Recently, ISS formulate on demand nutrient generation technology consists of dehydrated strains of yeast and consumable substrate to generate instant nutrient compounds for expanded space journey **(Ball *et al.*, 2020).** This type of food items are very much safe and secure for space person. ISS distributes original fruits and vegetable by which they can consume as colourful salads **(Gomar-Serrano *et al.*,2015).** Irradiated foods are regarded as sterilised food items by irradiation. ISS has provision to irradiate the foods like meat or bread. Moreover, instant food substances are nutrition bars, noodles made through utilisation of gamma radiation. Noteworthy, functional foods consist good nutrients therefore these promote good health properties for Astronauts **(Smith, 2016).**

Hindrances of Space foods

Controlling process of food consumption over natural foods

In general, space person carries processed as well as packed food items. Raw and natural fruits and vegetables are accepted by Astronauts in case of short-term missions because there are finite storing capacity and highly perishable **(Buckley *et al.*, 2011).** Not only that, water if it is processed, partly dehydrated foods therefore carrying cost is very much high. So that, ISS designate the low weighty processed food components but have adequate nutrient composition that is caused of reliable cost which is interlinked with shifting the new and natural foods. cosmonauts always prefer healthy foods like natural fruits and vegetables as these carry much essential nutrients like vitamins, minerals, fibres, secondary metabolites **(Laurens *et al.*,2016).**

No standard in frozen food constituents

Fuel cells distribute water as a consequent compound while energy is formed. ISS newly formulate solar cells to produce energy from the Sun. water, electric are foremost essential and have short expedients because have restriction in the weight at space flights these create biasness to serve the freezers or refrigerators. Solar system maintains the quality of frozen foods by preserve this **(Cooper *et al.*, 2011).**

Short conveyance and storing capacity

Misemployed the power, crew time management, waste products deposition gives the bad impacts to space. Because of it is very much costly to carry the compounds from earth to assist expanded space journey. Therefore, required to formulate the recreate and independent systems for water, food and energy.

Expanding dietary compounds for storing and cooking

An expanded journey of mission should conserve an adequate tasty, have nutritional importance and also have food security for 3 to 5 years. Noteworthy, NASA has an objective to grow fully nutrient rich and ecologically justifiable foods compatible along with cooking process during microgravity **(Cooper *et al.*, 2011).** But it is very much demanding to utilise this similar cooking methods to build food lists for space in greater than 3 to 5 years in the absence of alteration at standard of food menus that express good extensive health benefits.

Exhaustion of diet menu

Food palatability may be pretentious through the pattern of food consumption. Intake time may advance unanimity of cosmonaut therefore promote an essential psychological and social benefits. Adequate food consumption to decrease the psychological and social biasness. Adequate food consumption decreases psychological distress after also excessive task in mission. However, appetized food promote satisfaction for astronaut. Furthermore, good organoleptic properties of space meal establish better impact on central nervous system of space person **(Bumgarner *et al.*, 2012).**

Authors have reviewed that, at the time of mission in Mars (MARS500) in Russia Astronaut have experienced "Diet menu fatigue" and they flatter exhausted and also refuse their preferred foods **(Bhatia *et al.*, 2018).**

Nutrient insufficiency

In mission, nutritious space meal must need to promote good effect by inclusion of nutritive food components that involves to assist the gut brain axis in utmost situation at space **(Cena *et al.*, 2003).** On the other hand, the minimised gravity and circadian rhythm of heart are the facet of space flight. However, there is required the compact study about the modification of auxiliary situation, for instance modification of food flavour during the alteration of atmospheric condition and conversion of digestive, olfactory, and perception arrangement in space journey for long term.

The impact of unfavourable situation upon health of Astronauts

Extensive review of literature has confirmed that, the habitat in space is very much distinctive from ecology of Earth. Space person accept many intricate and adverse challenges for survivance of people. For instance, from space flight authors have noted that, ecosystem of space is featured by microgravity and 90 minutes light and dark cycle activate the adaptivity from physiological system. This resilient retaliation may be caused of decreased body mass, transportation of fluid, hamper electrolyte balance, decrease hydration, prevalence of constipation, lesion quantity of potassium, calcium, red blood cells, disturbance in gut and also indisposition in space station and so on **(Munevar, 2014)**.

Low quantity of energy consumption and decreased weight

Previous literature has confined that, people in Earth always prefer escalated proportion of protein or carbohydrate that is interlinked along with extended weight preservation after decreasing the weight **(Drummen *et al.*, 2020).** Authors have noted that, for space person it is very much difficult to follow energy stability in extended journey at space flight **(Wade *et al.*, 2002)**. The negative homeostasis of energy shows lesion weight. Space person astray their weight 2 to 5 % in pre-flight **(Zwart *et al.*, 2002).** Furthermore, greater than 10% loss in weight is noted at space however there is plenty number of foods available. A big journey for Mars may shows 15% or more weight burn that promote serious health hazards. Authors have reviewed that, gloomy homeostasis of energy may promote some metabolic distress like fatigueness in muscle, complicated cardiovascular disorders, enhanced infection and inflammation, damage alleviation in wound, sleep disturbances and lesion the chances of physiological comfort. Chronic malfunctioning of energy may leads to cardiovascular malfunctioning, loss the compactness in bone, damage the capacity in exercise and loss immunity **(Smith & Zwart, 2008).** Space person should consume much quantity of foods to balance and lesions the intake of energy caused of microgravity, tiny amount of space capacity, unable to maintain exercise, frequently alter circadian rhythm modification so that, bad taste of refined and packed food components may be another aetiology to consume in lesion quantity **(Bergouignan *et al.*, 2016)**. Furthermore, microgravity does not alter the metabolic energy that means nutritional component move into blood by intestinal membrane for utilisation through cells needed to live well. The loss of energy is another aetiology of decisive homeostasis in energy. Extensive review has notified that, microgravity in space flight shows to enhance the two hormones like leptin **(Rudwill *et al.*, 2018)** and GLP-1 **(Bergouignan *et al.*, 2016)** that is the caused to promote satiety. These altered appetite hormones can fallen down the appetite in space flight. Another biological factor also gives an impact on appetite for instance space person has fondness upon carbohydrate than fat **(Lam *et al.*, 2010).** In space flight, decreased food consumption, hampered anabolic feedback can lesions the formation of reactive oxygen species (ROS) in mitochondria which promote age related disorders, cell death **(Valko *et al.*, 2007).** Physical exercise in space station is the foremost proposal for keeping adequate muscle and bone mass which enhances sum of energy expenditure therefore, adequately energy consumption is very much needed to continue the energy homeostasis. Exercise can hamper the eating strategy in space also **(Bergouignan *et al.*, 2016).**

Consequences of microgravity

In case of microgravity, the energy of everyday operations is greatly decreased caused to muscle wasting. Retaliation of microgravity such as fluid reallocation, decreases quantity of plasma, dropping the activity of muscles, cardiovascular complication, hamper immunomodulation, disharmonise the central nervous system **(Lang *et al.*, 2017).**

Extended radiation

Radiation in space manifest the lots of symptoms like hamper DNA **(Kryston *et al.*, 2011)**, age related macular degeneration. **(Wang *et al.*, 2016).** Oxidative damage is another cause of radiation in space which leads to age related distress **(Hohn *et al.*, 2017)**. Nutraceutical enriches foods like anthocyanin and ω-3 fatty acids lesions the complication of radiation **(Delp *et al.*, 2016)**.

Metabolic tensions

It enhances metabolic rate, stop the triggered immunity. Furthermore, it enhances the complication of type-2 diabetes and cardiovascular disorders **(Delp *et al.*, 2016)**. Oxidative damage and infections are cause of atrophy in muscle mass **(Hohn *et al.*, 2017).** It have great efficacy on metabolism of micronutrient like iron which can leads to iron deficiency anaemia **(Wang *et al.*, 2016).**

Alter the physical situation

Space person spend their relaxing time on couch as restricted movement and decreased exercise ability so outcome is that, cosmonaut have similarity with sedentary and indolent adult person and also human who are cramped to berth **(Hargens & Vico, 2016)**. In phase of laze, the temperature of space person is 1^{o}C inflated rather than Earth **(Stahn *et al.*, 2017)**. This may be ascribed to diminish the shifting of convective heat and evaporate to settle down the body temperature, loss weight, hyperthermia, also difficult physical exercise can conduct "Space fever".

Disease in gut

Microgravity lesions the community of good bacteria on the other hand enhances the level of bad bacteria in the gut. More over alters the function of gut microbiome which influences the digestion and absorption in gut **(Ying *et al.*, 2007).** In closed situation of space some infestations are pronounced in Astronaut's body such as meningitis in cerebrospinal, penicillin aversion to Staphylococcus leads serious complication for space person **(Cucinotta *et al.*, 2017)**. Noteworthy, fluid and electrolyte imbalances are also observed for short- and long-term missions in Astronauts.

Biased vision

Vision capacity is very much altered in cosmonaut after landing from space flight. Altered the composition of eyes and manifestations of increased intracranial stress **(Zwart *et al.*, 2012)**.

Absence of nutrient components due to preserving and refining

In case of extended mission plan, malnutrition has shown in Cosmonauts. Refined and preserved food components which have short shelf life. furthermore, NASA needs 18-24 months for preserving the space foods that is not sufficient. However, extended mission needed the 3 to 5 years for maintaining the adequate quality of foods in space **(Catauro & Perchonok, 2012)**. It is a challenge to keep up the space meal's quality keep up to 5 years. Authors have noted that, if space foods drop their standard in the initial 2 years at unit of the Space so it will be not utilised the space foods extends than 2 years while food items establish adequate nutrition for early 2 years **(Cooper *et al.*, 2011)**. Moreover, preserving the temperature along with time promotes good efficacy about the presence of vitamin in space foods. Authors have revealed that, while the preservation temperature 27°C for fruits and vegetables outcome is that, Vitamin C, Vitamin B_1 and vitamin B_2 are dropped at 58%. Furthermore, the storage temperature when 10°C therefore, 38% vitamins are lost **(Stein, 2013)**. For extended space mission, thermally stabilised space foods have dropped nutrients, decline the flavour and the alteration of another food grade. Noteworthy, flavour of the foods is altered according to time exhibits as rancidity, few aromas and totally lesions of flavour **(Smith *et al.*, 2013).** Moreover, breakdown the concentration of vitamin like vitamin A, vitamin, C and vitamin K and minerals like folate and thiamine in case of preservation for over period of 880 days. In the year of 2010, Gordon Cooper preserved the space foods for over 5 years at 22°C. and have observed that, alteration of 24 distinctive vitamins and minerals for 1, 3 and 5 years. Outcome is that, thermal stabilized foods are more prone to loss the vitamin A and C, vitamin B_1, folate. Simultaneously, oxidation also involves to breakdown the vitamin concentration at the time of preservation. Breakdown the concentration of Vitamin A in initial storage time. folate and thiamine parameters are fallen down. Vitamin C parameter are also dropped at 37 to 100%. Moreover, dropping nutrients at 3 to 5 years that shows undernutrition in food matrix. Ordinary preservation method unable to keep the good food standard for extended mission of space **(Douglas *et al.*, 2020)**.

Conclusions

Based on extensive literature review, prolonged space journey is very much stretching rather than short expedition in space. Authors have found that, in case of long space voyage there are present various predominance factors which creates prolonged biasness during journey of cosmonauts including quickly lost shelf life of natural fruits and vegetables, frozen foods have no standardization, stubby transference capacity, insufficiency in cooking and storage, diet menu fatigue, inadequacy of nutrient. Furthermore, antagonistic situation may lead to various complication in Astronaut health for instance minute quantity of energy intake therefore no upgradation in weight, extensive muscle wasting due to microgravity, various metabolic disorders, widen radiation, ailments of gut, insufficiency in vision. Precisely, artificial gravity must be promoted to create safeties in crew health through authorization the utilisation of enclosed loop life support arrangement except enhancing the protection probability along with extended microbes' contaminant in microgravity.

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