

Issues of Space Agriculture Concept

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Space agriculture is engineering for sustaining activities of crew on extraterrestrial bodies, such as Mars, by function of biological and ecological elements. Agriculture was invented about ten thousand years ago. It enabled to provide foods more than self consumption, and to start human civilization. Astronomer was the earliest scholar, and contributed to develop agriculture with innovation of calendar. Emergence of modern science and industrial revolution proceeded about three hundred years ago. Modern agriculture based on scientific achievements allows our future of exploring extraterrestrial bodies and space agriculture on them. Healthy curiosity towards space might be a key for maintaining our civilization sustainable.

For Earth orbiting station or Moon base, open system is the appropriate choice for life support. Foods are carried from ground, and recycling is limited to water, of which consumption rate is high. Recycling of foods and oxygen from metabolic waste and inedible biomass requires huge initial investment for its system. Space agriculture would be selected at the phase of larger and longer manned mission beyond Moon, where integrated amount of consumable becomes larger than investment and operational cost for recycling system. Beside of this economy for life support, survivability is the highest priority in life support engineering. Space agriculture relies on supreme functions of biological and ecological system. However, they turn to a black box with confidence or reliability less defined. Study for closed ecological life support has been oriented to improve degree of closure in materials recycling loop, and minimize quantity of drop out of materials from the loop. We consider survivability as the top priority, and recycled food and other resources is stored to fill the needs of the next crew. Space agriculture will import on site materials resources into the loop, and realize more than 100 % expanded recycle. Available on site resources are carbon dioxide in atmosphere, frozen water in subsurface, and biotic elements in regolith and rock. We should plan and conduct preceding exploration to confirm feasibility of utilization of those resources. We develop phased deployment of space agriculture based on its results. Forward quarantine must be strictly implemented in space agriculture in order to save the exploration target from terrestrial contamination.

Once survivability is secured in life support function, our target will be improvement of crew productivity and emergence of comfortable living environment in outpost on extraterrestrial bodies. Space agriculture is extended from materials recycle to the whole engineering to produce living environment and improve its amenity. In this context, space agriculture is scoped with its associated area, such as psychology of space mission, and space architecture for pleasant living. These aspects are important for long space mission under stressful factors.

Space agriculture will be chosen at the phase of manned space exploration to Mars at large and long scale. However, it would be an effective testbed for engineering solving global problems, such as shortage of farming ground against increasing human population, and severe deterioration of land. Among them, entomophagy by raising insect without competition of food crop production is an excellent contribution to life support engineering for space exploration from traditional culture of Japan and east Asia.

Keywords: space agriculture, Mars exploration

Study of Space Foods - Taste and smell -

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Purpose

Space foods must be safety food. And the space food is not only safety food but also the nourishment food. In addition, the space foods are demanded to make mental stability. A long-term stay in the space was enabled now. From this, the importance of space foods rises more and more. Therefore it was decided that this study studied taste and the smell that were important to space foods.

Method

We did examination of taste and olfactometry for 14 elderly people (65 years or older: 2 male, 12 female). We did examination of taste by using taste disc (Sanwa Kagaku Laboratory Corporation). Disc include 0.3%, 1.25%, 5%, 10% and 20% of salinities in the filter paper. We did examination of smell by using smell stick (Daiichi Yakuhin Kogyo corporation). 12 different kind of smell (India ink, Hinoki, perfume, menthol, rose, mandarin orange, home gas, sweat socks, wood, curry, condensed milk and fried garlic) were examed.

Result

The average age of 14 people was 73.6+/-3.9 years old (66 years old - 78 years old). The average of the weight was 53.6+/-8.2 kg, the mean of the percent of body fat was 33.0+/-6.0%, the BMI level was 22.3+/-3.4 kg/m/m. Four subjects were identify 0.3% of salinities and ten subjects were identify 1.25% of salinities.

Discussion

During the long-term stay in space, our body mass index is changing. Percent of our body muscle is decrease and percent of our body fat is increase. Our result shows, long-term stay in space, we worry about our sense of smell decline. And also, we want to collect data more and examine aging in the sense of taste. In future, we hope to make more delicious and more fragrances space food.

Keywords: Space foods, taste, smell

Importance of the lactic acid bacterium intake in space foods

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Purpose

We will worry about some physiological change in long-term space stay. Especially, constipation will be a problem for astronauts. Constipation will be cause of disease of stomach or bowels. In this study, subjects eat two different kind of yogurts to check the ratio of constipation.

Method

The subjects were 11 adult women (average age 20.9±0.3 years old) registered at this study. During two weeks before experiment start, we performed questionnaire survey of the bowel movement situation everyday. (the "color" "shape" "smell" "bowel movement time" "stool frequency" "number of times of the gas"). For two weeks, we took 85 g of M Company yogurt before going to bed and recorded the bowel movement situation everyday equally afterwards. We stopped a yogurt intake for the next two weeks and recorded the everyday bowel movement situation.

Furthermore, for two weeks, we took 100 ml of Y Company yogurt and recorded the bowel movement situation everyday equally. We stopped a yogurt intake for the next two weeks and recorded the bowel movement situation everyday.

Result

From the 2-week bowel movement record before the experiment start, we divided them into two groups, constipationless groups and constipation group. As a result of having taken M Company yogurt for constipation group for two weeks, one person was improved so that there was a bowel movement approximately every day. And then, we stop yogurt intake for the next two weeks. Afterwards, as a result of having taken Y Company yogurt for two weeks, two constipation subjects were a bowel movement every day, three constipation subjects were improved and answered it that one constipation subject was not improved.

Consideration

When we do yogurt intake for two weeks even if it was either product, constipation tended to be improved. But when we stopped an yogurt intake in the case of both we have a problem of constipation again. We understood that it was important to continue an yogurt intake in the constipation improvement. We do an experiment period more for a long term, and it will be necessary to perform closer questionnaire survey in future.

Keywords: Lactic acid Bacterium, Space Foods, Constipation

The results of sensuality examination of the commercial disaster food - For seasoning of the future space foods-

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(Background and purpose)

At the present, long-term stay in the space is possible. The importance of the meal in the space rise more. Development of the space food which can store for a long term is urgent business. Because, we think about an exploration and emigration to Mars.

However, we have to think about the mental for the astronaut, first. Delicious space food is very important for the astronaut to keep their appetite. We have to think about not only nutrition but also taste in the space food. Therefore in this study, we examined sensuality of the commercially food which can keep for a long term. And based on the result, we thought about the taste and smell in future space foods.

(Methods)

Thirty eight female college students (20-21 years old), they eat some commercially available rice things (eight kinds) and pasta (three kinds) which can store for five years.

And we performed to do sensuality examination for them. Students carried out the sensory examination and scoring (Perfect score is 10) of food. The marketing products are cooked with hot water in 15 minutes. "vegetable rice", "shrimp pilaff", "perilla and seaweed rice", "chirashi-sushi", "white rice" "fried rice", "beef rice", "dry curry", "neapolitan", "peperoncino" and "carbonara" of the magic rice (product made in Satake Corporation).

(Results)

An evaluation was high in the taste in order of "vegetable rice", "dry curry", "beef rice", "shrimp pilaff", "neapolitan", "chirashi-sushi", "fried rice" "perill and seaweed rice", "peperoncino", "carbonara" and "white rice". As for the highest score was 9.4Plus or minus0.79, the low lowest score was 7.9Plus or minus1.4. An evaluation was high in the incense in order of a "dry curry" "vegetable rice" "beef rice" "neapolitan" "fried rice" "chirashi-sushi" "shrimp pilaff" "peperoncino" "perill and seaweed rice" "carbonara" "white rice". As for the highest score was 9.3Plus or minus0.9, the lowest score was 7.8Plus or minus1.6.

(Conclusion)

As for both the taste and the smell, "vegetables rice" "dry curry" "beef rice" occupied the high rank. It is affected that this subject was a student in its twenties.

These foods are acceptable for everyone in the world. These foods will be able to eat as universal space food. This magic rice which is the food by making freeze dry method is very useful not only as space food but also as disaster food.

I should investigate the taste of the overseas astronaut to make an acceptable product to an overseas astronaut as space foods. And investigation is necessary to make delicious rice or the pasta. The subject was feeling that "the chirashi-sushi" is strong smell of the vinegar. In next our study, we should try the freeze dry product of the side dish. It is necessary to think about the combination as the meal in future.

Keywords: Long-term Preservation Food, Sensuality examination, Taste, Space Foods, smell

The use of the lactic acid beverage in space foods

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Purpose

The long-term space stay makes it possible to perform many studies. We think that the development of space foods will develop more in future. The meal management to maintain the health of an astronaut working busily is important. With lactic acid bacterium beverage, we thought that we want to perform the health care of the astronaut. Therefore we decided to check the effect on bowel movement of the lactic acid bacterium beverage.

Method

We assumed ten adult women (average age 20.5 years old) as subjects.

Before experiment start, during two weeks, we took the bowel movement record. We boiled Y Company lactic acid bacterium beverage (40% of calorie off) at 100 degrees during three minutes. During two weeks, we let them consume the lactic acid bacterium beverage which we boiled and recorded the state of the bowel movement. Another two weeks, we let them consume the lactic acid bacterium beverage which we did not boil and recorded the situation of the bowel movement afterwards. After the experiment end, we recorded the situation of the bowel movement during two weeks. The record contents were the "stool frequency" "smell" "shape" and "number of times of the gas".

Result

Before experiment start, we understood that there was not a bowel movement in five of ten people from a 2-week bowel movement record. In particular, three subjects were in a week only 2~3 times bowel movement. As a result of having consumed the lactic acid bacterium beverage which we boiled for two weeks, three subjects were in a week only 2~3 times bowel movement. Seven subjects were bowel movement every day in a week. Every day, eight subjects who consumed the lactic acid bacterium beverage which we did not boil had bowel movement. Another two subjects had 5 to 6 bowel movement a week. After period of this study, during two weeks, we investigated of 10 subjects bowel movement. After stop the examination, the bowel movement has returned as same as before.

Discussion

The oligosaccharide included in the lactic acid bacterium beverage helps an enterobacterial increase. The lactic acid in the lactic acid bacterium beverage helps enteric work lively. However, the action of the lactic acid bacterium is not more active if we do not consume lactic acid bacterium beverage continuously. It is necessary to utilize lactic acid bacterium beverage to let intestinal bacteria act more actively.

Keywords: Lactic acid, Beverage, Space foods

Study on food allergy in space foods

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Purpose:

In space, we have to think about anaphylactic shock to eat space food which include allergen accidentally. We have to know some cases of anaphylactic shock may have result in death. Even if an allergen is not included as raw materials, we cannot deny possibility mixing in a manufacturing process. It is essential to inspect allergen by using an allergic kit because we need to protect our life by the meal which is one of the pleasure in space stay.

Therefore this study inspected allergen in the commercial foods by using allergen identification kit (Morinaga identification raw materials kit). Especially, peanut and soba (backwheat).

Method

We used an allergenic kit made in Morinaga Corporation. The marketing product inspected ten kinds of seasonings, seventeen kinds of food and nine kinds of cake.

Result

Result

We examined peanut first.

Among 20 kinds of food, seven kinds of food matched positive reaction. There is not allergen name but four of 14 kinds of food which were displayed were positive when it might be included in a manufacturing process.

We examined soba next.

Among 20 kinds of food, five kinds of food matched positive reaction. There is not allergen name but two of 15 kinds of food which were displayed were positive when it might be included in a manufacturing process.

discussion

In the cooking with a manufacturing process and future space foods in the spaceship, we think that it is necessary to be careful enough.

Keywords: Allergy, Space foods, Seasoning

The low GI food is suitable for space foods

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Purpose

We became able to stay in the space for a long term. The offer of the meal appropriate to the active mass in the space is necessary. Therefore a menu offer to become the meal contents which are hard to go up of the blood sugar level is necessary. Metabolic syndrome becomes the problem on the earth. It is necessary to inform how it is important that we prevent hyperglycemia after a meal widely. Similarly, in the space, you should consume the meal which is hard to go up of the blood sugar level. It is important that we do disease prevention. Therefore in this study, we made a menu (low GL food menu) which was hard to go up of the blood sugar level using food (low GI food) which was hard to go up of the blood sugar level.

Method

We collected low GI foods. We put low GI food together and made the low GL food menu which was hard to go up of the blood sugar level. We use this menu and we measured blood sugar level by using peripheral blood. We checked our menu which is really became the low GL by using peripheral blood. We check our blood sugar level by using Kit (product made in Terumo Corporation), before eating this food and after 15 minutes, 30 minutes, 45 minutes, 60 minutes, 90 minutes and 120 minutes. In addition, I performed the sugar load examination with glucose. We compared a low GL level between the actual value and the calculated value.

Result

In the GL level, the actual value is higher than calculation. In addition, cooking method was very important to make low GL menu. When we make soft food and eat it, our blood sugar level become high easily. Because when we make stew softly, the GL level of the actual survey became higher.

Discussion

We think that it is desirable to perform by using low GI food to make low GL menu. And we think that the cooking method is very important to low GL menu. The space food must be good balance diet. By feeling of satisfaction and slow digestion and slow absorption, it is possible to prevent a sudden rise of the blood sugar level.

Keywords: Low GI, Low GL, Blood sugar level, Diabetes

Importance of the menu making by using the blood sugar level in space foods

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Purpose

Now, the long-term stay in the space is possible. The importance of the meal has been understood by many people. We think that the space food study is made more and more in future. Therefore, in this study, we try to make balanced diet menus for space food.

Furthermore, we make the healthy universal space foods that blood sugar level is hard to rise.

Method

We made a balance menu. We measured our blood sugar level by using a blood sugar level measurement kit made in Terumo Corporation. We measured blood sugar level by using peripheral blood (before eating and after 15 minutes, 30minutes, 45minutes, 60minutes, 90minutes and 120 minutes). In addition, we performed the sugar load examination with glucose. We compared these level and confirmed whether it became the low GL food menu. The food used low GI food as much as possible.

Result

We understood that it was necessary for the low GI food to think about staple food first. When we eat unpolished rice + 30% wheat, blood sugar level is more lower than we eat polished rice. We was able to keep blood sugar level low by controlling quantity of glucide among the whole menu. We increased dietary fibers and was able to lower blood sugar level by using vinegar and oil.

Discussion

The making of menu increasing dietary fibers will be more necessary in future. We would like to study about the effect of oil and the vinegar more. We want to make the universal balance space foods menu for everyone in the world.

Keywords: Low GI, Low GL, Blood sugar level, Menu