

FOOD AND NUTRITION FOR LONG MISSIONS IN SPACE

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 81 pp 42-43

[Article by I. Popov, candidate of the medical sciences: "Nutrition on a Long Space Flight"]

[Text] Many new problems have come up with the increase in the duration of manned space flights. Concerns have also increased markedly among specialists handling the nutrition of the cosmonauts. It has been necessary to obtain more precise data on the needs of the organism for the chemical substances obtained from foods. For this, research has been conducted on the ground, the experience of previous missions has been taken into account and the results of medical, biological, biochemical and physiological experiments performed in space have been used. This has made it possible to refine the food rations and bring them into line with the needs of the cosmonauts' organisms and the energy expenditures. As a result, the calorie content of the daily food ration of the crews of the "Salyut-6" orbital station was increased by 300 kilocalories and now amounts to 3,200 kilocalories; products have been incorporated in it which promote the normalization of the metabolism under conditions of physiological tension (stress).

With the start of long missions, even greater attention is being devoted to the preservation of good quality and taste of the products on-board the station. For this, their packaging has been improved, they are subjected to preliminary processing using more sophisticated technological procedures, and special substances are introduced in them, in particular, antioxidants.

The cosmonauts began to make wider use of dehydrated products with the installation of a water recovery system from the atmospheric moisture in the "Salyut-6". This has made it possible to increase the stock of food on-board and diversify the assortment.

The crews of the "Salyut-6" heat food not only in dispenser tubes, but also canned meats and bread. The cosmonauts now have one to two hot dishes and it has become possible to use the food rations for a longer period of time.

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The change in the taste perception of cosmonauts in flight against the background of fatigue was subjected to a special study. As a result, the scientists came to the conclusion: in order to improve the appetite under such conditions, it is necessary to add different spices and condiments to the products stored on-board the station. **AMAZING**

As early as the preparation for the first orbital missions, the problem of providing the crews of spacecraft with food and water was numbered among the major problems. And this is no accident: even under ordinary conditions, high quality nutrition in terms of the composition and conditions plays an important part in maintaining man's health and work capability. And with stressful physical and intellectual work, when various unfavorable environmental factors act on the organism, the value of nutrition increases even more.

In the early stages, the practical solution of these problems was facilitated by the short term nature of the mission. As applied to the conditions of living in spacecraft designed for missions of up to a few days, a system was designed for the on-board nutrition which was maximally simple in terms of equipment. It included a stock of food products in the form of daily rations, two containers: for their storage and to collect the food leftovers as well as packages and adapters to facilitate the preparation and eating of the food. Its major component is the daily food rations. The size and weight characteristics, as well as the specific features of the set of products, the consistency and packaging in the daily rations were determined by the structure and composition of the individual components of the nutritional system,

Requirements were placed on the daily rations which have not lost their importance up to the present time. They should primarily correspond to the energy requirements of the cosmonauts during the mission, have full compositional value and maximum assimilability of the major nutritional substances: proteins, fats, carbohydrates, mineral compounds and vitamins. It is necessary that the food maintain its good quality under storage conditions at 20 to 25 °C and stay safe throughout the entire mission, have sufficiently good taste qualities, which provide for its maximum utilization even when the appetite is reduced, and not become boring. Moreover, it should be convenient for intake in weightlessness and not require additional culinary processing, heating, cutting or special dishware.

The combining of these and other qualities in one daily packet is far from a simple matter, all the more since there are no analogs used under ground conditions. Only the flight rations for a flight crew, introduced into supply in 1958 and intended for aircraft crews during flights lasting more than four hours were the closest of all to the requirements enumerated above. The experience in putting it together was also used for the space ration.

The daily ration of the cosmonauts who flew in the "Vostok" and "Vostok-2" ships contained about 2,800 Kcal, including 100 grams of protein, 118 grams

of fats and 308 grams of carbohydrates. In terms of calorie content, such a ration is recommended under ground conditions by the Institute of Nutrition of the USSR Academy of Medical Sciences for persons whose work does not require substantial physical effort and is therefore accompanied by a lifestyle with a small amount of motion (the first profession group). The balance in the ratio of proteins, fats and carbohydrates was 1:1:3.

For a comparison, we recall that the flight ration in jet aviation is of high calorie content, something which is due to the considerable energy stress of the work of a flight crew. Because of the use of exclusively preserved products which are not vitamin enriched, as well as the elevated consumption of vitamins by cosmonauts, supplied in addition to the natural products in the dispenser tubes was a multivitamin drop containing vitamins C, B₂, B₆, P, PP, E and pantothenic acid.

The energy expenditures of test subjects fluctuated from 1,754 to 2,549 Kcal per 24 hours (2,000 Kcal on the average) during modeling of the flight work and rest conditions on the ground, something which guaranteed that a ration of 2,800 Kcal would be adequate, and even have a definite reserve.

Besides products in dispenser tubes, samples of solid consistency products (pieces of bread, smoked sausage, etc.) were placed on board the "Vostok" and the "Vostok-2" ships in polyethylene packets for an experimental check of the possibility of eating them in weightlessness. During the mission of Yu. Gagarin, there was essentially no necessity for additional food intake. However, for the further development of space nutrition, such an experiment was extremely important. For this reason, in the 30th minute of the mission, Yuriy Alekseyevich ate and drank in accordance with the program. His conclusion that "everything went the same as for us on the earth", became not only the first evidence of the possibility of taking in, chewing and swallowing liquid and solid food in weightlessness, but also opened up the road for the use of products of different consistencies in subsequent flights.

Daily rations which were more diverse in terms of their composition were developed on the basis of studies during the first missions. Products which were used on earth in liquid or puree form were put in dispenser tubes: soups, cottage cheese as well as drinks: coffee, cocoa and juices. Snack products though, bread products, appetizers as well as sweet pastry products and fruits were packaged in film packets made of viscotene. Some of the products were vacuum packed to preclude contact with the oxygen of the air and better protection against contamination. The cosmonauts successfully used these rations during missions on the "Vostok" and Voskhod" type ships.

However, the rations which were developed had limited shelf lives without a refrigerator (up to five to six days). For example, meat products in packets had to be prepared directly prior to flight. They were delivered in cooled

containers to the spaceport, where they were placed in a refrigerator. If they were not loaded on the ship in two to three days, then it was necessary to prepare and deliver a fresh batch of packets.

For the cosmonauts who flew the missions in the "Soyuz" ships, new daily food rations were created, which consist of products which can be stored for a long time at room temperature without a refrigerator. Pureed and liquid products in dispenser tubes have proved themselves good after storage: soups, juices and drinks. The assortment of packets of bread products which become stale slowly was expanded (wheat, table and Borodinskiy bread). The bread products were baked in the form of small "one bite" rolls. This prevented the appearance of crumbs.

Meat products (ham, steak, veal) were prepared in the form of meats preserved in metal cans. The "Rossiyskiy" processed cheese was also packaged in the same way. The sweet products included chocolate candy, prunes with nuts and honey gingerbread (all in film packages). Some of the products in the form of briquettes were covered in edible film. The rations had a menu planned for three days. Food was to be taken four times a day.

The rations of the cosmonauts who flew in the first "Soyuz" ships also included products made of dehydrated boiled meat which were packaged in film packets and vacuum packed. However, their use made a negative impression on the cosmonauts. For this reason, they were subsequently replaced by conventional canned meats. Other dehydrated products (cottage cheese briquettes with black current puree, milk concentrates and cakes) were successful and have been used up to the present time.

Starting with the mission of the "Soyuz-9", the cosmonauts started to heat the first meals and drinks in the dispenser tubes up to 60 to 70 °C.

With the design of the "Salyut" orbital station, the living conditions improved and the system of nutrition was further developed. There is a buffet table on board the station for taking in the food, as well as a set of table accessories, a food heater, facilities for sanitary cleaning of the table accessories and bags for collecting the food leftovers and packaging. Because of the implementation of physical training exercises during the mission as a means of combatting the negative consequences of weightlessness, the calorie content of the rations were increased up to 3,200 Kcal.

The cosmonauts P. Popovich and Yu. Artyukhin on the "Salyut-3" were the first who tested dehydrated products, restored during the mission using recovered water. These experiments were successfully continued by the crews of the "Salyut-4" station.

The incorporation of dehydrated products into the rations was due to the effort to reduce their weight, increase the shelf lives and improve the nutrition of the cosmonauts through the use of products which differed little

from natural products in their taste qualities. Dehydrated products now comprise up to 10 percent of the food rations.

The dehydration of the products is accomplished by means of freeze drying. The finished main courses and appetizers, as well as juices, are subjected to rapid freezing, and then dried out in a vacuum. As a result, the water is removed from them, avoiding the liquid phase. No more than 2 to 3 percent water remained in the products. The product is immediately packaged in special film packets which are vacuum exhausted.

The cosmonauts in the orbital missions prior to the "Salyut-4" were fed exclusively using stocks loaded on the craft at launch. The second crew of the "Salyut-4" took along an addition reserve of products having a limited shelf life, as well as bread, coffee and tea for the first time in the transport ship.

Subsequently, the delivery of fresh food rations to the orbital station along with the next crew became widespread. This is now being primarily accomplished to an even greater extent by means of the unmanned "Progress" transport ship.

During long missions, the cosmonauts become even more discriminating in their eating and they place especially high requirements towards the end of the flight. This is readily explainable: no matter how diverse the set of products, something new and fresh is desired. Fatigue also has an impact. For this reason, they are now supplied with all possible seasonings. They are included in the dispenser tubes and dehydrated packets. These are the "Moldova" seasonings, sweet cranberry-apple sauce, dehydrated with horseradish.

The cosmonauts voiced the wish to have fresh vegetables and fruit on board the station, so that the food would taste more like freshly prepared dishes, rather than canned ones. They wanted the products to have improved packaging: easily opened cans, as well as packets more convenient for use with conventional and dehydrated foods, so that there would be fewer protective coverings.

Unfortunately, not all of the requests can be met as yet. But the search is continuing; and primarily in the direction of increasing the taste of the food products. Individual tastes of the crew members are being taken into account. Food which does not appeal to the cosmonauts is replaced by other food, of equal nutritional value.

The water supply system on board the spacecraft now functions in conjunction with the food system, since cold and hot water is needed to restore the dehydrated products. The store of drinking water in the orbital station is produced at a design rate of up to two liters per man per 24 hours.

Thus, the on board food and water supply systems in our spacecraft and orbital stations are being continually developed and improved in line with the new tasks of space flight.

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