Original Contribution

Journal scientific and applied research, vol. 2, 2012
Association Scientific and Applied Research
International Journal

ISSN 1314-6289

THE REMOVAL OF EXCESSIVE MOISTURE ON SPACESHIPS AND SATELLITES THROUGH LYOPHILIZED FOODS AND OTHER LYOPHILIZED PRODUCTS

Veselin Ivanov

ARMEYSKA STREET 11, DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY, MEDICAL FACULTY, TRAKIA UNIVERSIT, STARA ZAGORA 6000, BULGARIA,
veskoasenov@abv.bg

Abstract The moisture in the spaceships and satellites is one big problem disturbing the normal functioning of number of devices and worsening crew's conditions of life. Lyophilized products are extremely hygroscopic. Foods for astronauts are conserved through lyophilization. That means, lyophilized products, including and lyophilized food products, in principle could be used to eliminate the excess of water.

Key words:lyophilization, lyophilized blood products, lyophilized foods, spaceships, moisture, gas mask, absorption, submarine

Lyophilization is a process of extracting water from food and other products (e.g. erythrocyte mass, plasma proteins, blood serum, collagen from pigskin and others), so that food or products stay stable, easier to keep under room temperature [1, 2].

Lyophilization is being done using a simple physical principle, called sublimation. Sublimation is the transition of a substance from solid to gaseous condition, without going through intermediate phase liquid [3]. Lyophilization as a method presents drying of some products in low temperature, in vacuum. Temperature of water boiling depends on external pressure. In low pressure it goes down, which creates possibility products to get dried. In sublimational drying are combined two ways of conserving – freezing and drying in vacuum, in temperatures, not over the critical ones, in other words, temperatures in which micro- and macrostructure of the product is being impaired. Sublimational drying consists in separating the water substance from solid matrix of the product, in environmental pressure lower than the triple point of water. In its own nature dryness is an equal process, leading through moisture- and warmth-transfer, to a certain constant physicochemical parameters of product and before everything, to a certain residual moisture content. Process should be done in a way that secures the required decreasing of moisture, without worsening the

biological value of the food product and its quality indicators.

Lyophilization is multi-stage process that includes:

1) Freezing of the products to low temperatures, so that the water in food (not nutrient respectively product) becomes ice; under vacuum, ice sublimates directly in steam.

2) Primary drying, where the new-formed, during the freezing, icy crystals sublimate under the influence of initial intensive, and after that moderate heating, in conditions of high vacuum;

3) Secondary drying, where residual moisture is being desorbed, in positive temperatures and conditions of higher vacuum;

4) Completing the process, by reaching a specific final residual moisture of the product, where the vacuum, in the sublimational chamber, is being impaired with dry inert gas, product is being packed up and stored [4].

Subject of sublimational drying are all kind of foods, except for foods with fats. The technology of sublimational drying is suitable for production of mass-consumed food, as well as a specific dietetic and functional foods, including and foods for astronauts. The consistence of moisture in the product and the character of its connection with the material, influence over the continuance of drying and its speed. In sublimational drying is imperative 70-90% of moisture in the product, to be exuded in negative temperatures, so that to be guaranteed its high quality. Part from the left, the most closely related water, could be exuded only in positive temperature, in the phase of desorbtion [5].

Sublimational dried products are lean, dry, light with porous structure. They keep their original form, structure, color, smell, taste, vitamin consistence, mineral substances, amino- and fat acids, proteins and etc. The residual moisture content is practically equal distributed over the entire volume of the product, e.g for lyophilized blood products it is from 3 to 6 % [6]. For most of the vegetables and fruits it is in within the boundary of 2-3%, for meat and eggs – 4-5%, and in rich of starch potatoes, corn, beans, - 6% [7]. In a correctly performed sublimational drying, the final product is with low values of water activity (aw is within the boundary of 0.3-0.5). Water activity parameter gives information about the water condition in the material and accounts that part, which could be exchanged with the environment and it is available for chemical and biological interactions. Water activity is fermentational stability of lyophilized products [8].

Sublimational dried foods usually are highly hygroscopic. The absorbed water vapors from the air, which leads to sharp increase of moisture content of the product and worsening its qualities. The selection of suitable wrapping is necessary condition for effective and long-term storage of lyophilized products [8]. In hermetic closed wrapping (of materials impermeable to gases and vapors)

they could be stored for a continuous period of time – 5-10 years, without changing their qualities. That way dried products could be quickly restored through re-hydration, where most of their basic phisico-chemical, organoleptic and nutrient qualities are restored.

Lyophilization has many advantages compared to other technics of conserving. Lyophilization retains quality of food, because during the process of sublimation, food stays at temperature, which is below the temperature of freezing. Lyophilized foods usually could be stored without cooling, and that leads to significant reduce of expenses for storage and transport. Lyophilization significantly reduces the weight and that makes the products easier to transport, e.g. many foods consist over 90% water. These foods are about 10 times lighter after lyophilization.

So that lyophilized foods and products are porous, most of them could be easily re-hydrated. Lyophilization does not reduce the volume significant, and because of that, water returns its place in molecule structure of the food, so quickly. That makes lyophilized foods suitable for astronauts' food (well conserved, with retained nutrient qualities, and in the same time very light), because for exporting of each gram payload into space are needful large amounts of fuel, respectively the price grows significant.

In the same time lyophilized products are highly hygroscopic. They absorb large amount of moisture, if they are left free in air [9]. Moisture is a big problem on the spaceships.

Perhaps it is possible lyophilized products to be used (e.g. collagen sponges, derived from pigskin) or even foods for absorption of excess of moisture. That way re-hydration with water in liquid condition will not be needed, and it could be saved. It is enough only to break the package of the food and to wait for a while, before consuming.

Lyophilized products could absorb toxic gases and vapor of many different toxic compounds [10]. Perhaps their quality could find some practical application in space or in submarines?

Reference

1. Ivanov V., Popov B., Nicolov R., Lyubchev. Static sorption capacity of lyophilised blood products for benzene and its derivatives. Trakia Journal of Sciences, Vol. 4, No. 3, pp 11-15, 2006

2. Ivanov V., Lyubchev L., Nikolov R., Arabadzhiev G., Haralampiev M. Comparative investigation of sorption properties of collagen and liophilised blood products. Conference of Union of science ‘’Days of science’’, Veliko Tarnovo, 2008, pp 257-261

3. Ivanov V., Popov B., Nicolov R., Lyubchev L. Investigation of static sorption capacity of lyophilised blood products for some halogenhydrocarbonas. Trakia Journal of Sciences, Vol. 5, No. 1, pp 1-5, 2007

4. Ivanov V., Popov B., Nicolov R., Arabadzhiev G. Effect of increased temperature on static sorption capacity of lyophilized blood products. Trakia Journal of Sciences, volume 5, number 2, pp 30-34, 2007

5. Nacheva I. Cryoprotective effect of some hydrocolloid types during lyophilization
of milk fermented foods, “Foodstuff industry”, 2001, 5, pp 6-8

6. Ivanov V., Dyankova Sv., Nicolov R. The quantity of pre-adsorbed humidity in lyophilized blood and blood products used like sorbents for gas mask. Scientific conference with international participation ‘’Stara Zagora 2004’’, June 3-4, 2004, Volume IV, pp 260-264

7. Nacheva I., Georgieva L.,. Tzvetkov Tzv. Freeze-drying- an alternative for overcoming of seasonality in fruit-growing, coll.papers from the IV-th scientific-technical conference of the young scientific workers and specialists in fruit –growing with international participation, Kjustendil, 14-15 October 1998, pp 28-31

8. Doneva M., Dyankova Sv., Metodieva P. Investigation of the catalytic activity of freeze-dried protease and amylase enzymes during storage, Plovdiv - Food Science, Engineering and Technologies – 2010, Scientific works v. LVII. 1, 453-458.

9. Tarelli E, Elphick AD, Gostick JD, Stammers RP. Additives to biological substances. III. The moisture content and moisture uptake of commonly used carrier agents undergoing processing conditions similar to those used in the preparation of international biological standards. J Biol Stand. 1987 Oct;15(4):331-40

10. Ivanov V. Investigation of new absorbents based on lyophilized blood and blood proteins for filtering gas masks. Ph.D. theses, Sofia Bulgaria, 2001