High Quality Dehydrated Meats

dehydration by freeze-drying method results in products with color, flavor, and food value characteristics of fresh meats

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All the essential properties of fresh meat—color, flavor, and nutrient content—are in the rehydrated product of freeze-drying.

Serving-size pieces of beef, pork, lamb, chicken, and fish were freeze-dried in studies on this method of dehydration and—after rehydration and cooking—proved to have high acceptability.

Only freeze-drying—of all methods of dehydration—has been applied successfully to meats without producing undesirable concurrent chemical changes, especially those of protein denaturation, which are caused by high temperature drying of meats.

The characteristic flavor of meat is developed during cooking and—as meat is usually served hot—the cooking process should be reserved until the time of eating. For this reason, meat was freeze-dried from the raw state.

Meat from hindquarters of steer beef—1,000-pound class—fattened in feed lots, properly aged and graded U.S.D.A. Choice, was cut into pieces 1″ thick and 2″ square. Random samples were used for the experiments, and a like sample was held at 0°F as a control for each sample subjected to organoleptic—color, texture, flavor—evaluations.

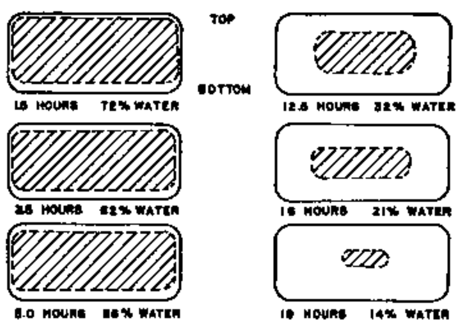
Freeze-dryers equipped with infrared radiant heating and heated hollow shelves were used to freeze-dry beef in 1″ thick, 2″ squares, and many retail cuts of meat, chicken, and fish. The freeze-dryer was maintained at 0.1 to 0.2 millimeters absolute pressure by a positive displacement vacuum pump in series with a condenser at -40F.

For purposes of comparison, pieces of beef of the same kind and size as those freeze-dried were dried by vacuum dehydration at temperatures of 32–59F and 86–113F, and absolute pressures less than 23 millimeters.

Dehydration at both the low and the high temperatures resulted in extensive case-hardening of the beef pieces, which was caused by a denaturation of the surface protein and an accumulation of dry soluble components translocated to the surface. The drying times were very long and the organoleptic properties of the beef pieces were poor.

In contrast to vacuum dehydration, the freeze-drying of 1″-thick pieces of beef can be completed in a shorter time and produces a very superior product.

Cross section of meat chunks showing regression of ice phase during freeze-drying.



SECTIONS WERE MADE DURING A PILOT RUN USING INFRA-RED HEATING

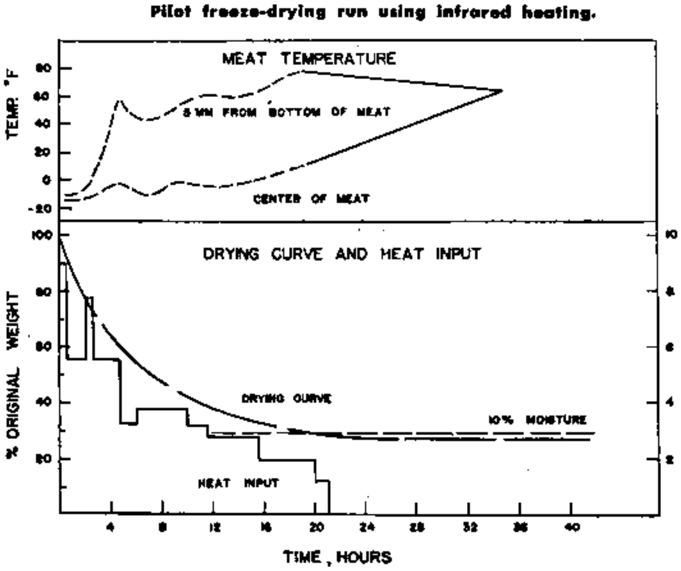
Freeze-Dried Beef

The properties of freeze-dried beef are listed in the table in columns 1 and 2 on page 5. Further characterization of the color of the freeze-dried and rehydrated beef is given by the reflectance spectra shown in the graph at the right on page 5. The pink color, characterized by its brightness and high spectral reflectance, is one of the unusual properties of freeze-dried beef.

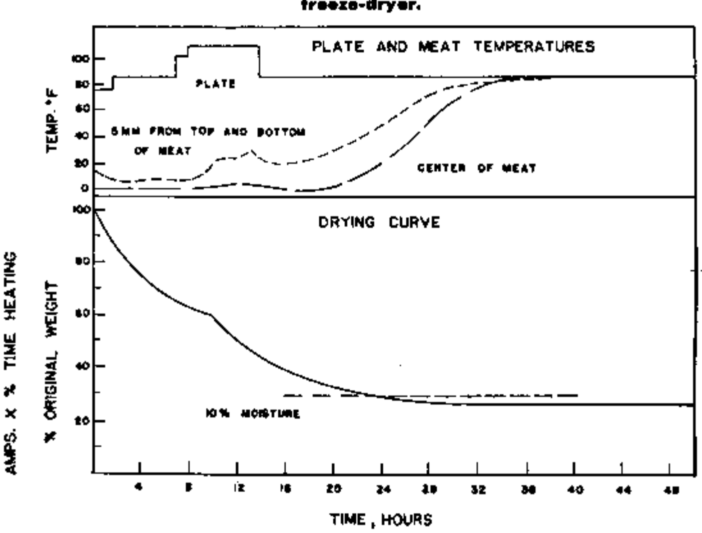
The rate of rehydration is primarily dependent upon the rate of flow of water through the capillary-like openings into the central portion of the blocks of meat. Rehydration of the actual meat proteins takes place very rapidly. Rehydration of whole beef pieces becomes rapid—five minutes—when the air is completely evacuated from the dried beef. The level of rehydration of freeze-dried beef is high and it can be increased by evacuation of the air from the dried beef. However, after cooking, the texture is usually drier than the controls, indicating less tenacious binding of the water.

Many comparisons of the organoleptic properties of freeze-dried beef after re-

Pilot freeze-drying run using infrared heating.



Pilot freeze-drying run using conventional plate freeze-dryer.



hydration and cooking with the cooked quick-frozen control indicated that in flavor and appearance the freeze-dried beef was not essentially different. A characteristic property of the freeze-dried beef has been its drier texture—a problem not yet resolved.

Tests Extended

Dehydration by freeze-drying was extended to serving-size pieces of a wide variety of meat, fish, and poultry.

Those animal products which have relatively impermeable surface layers require excessively long drying times unless the surface layer is removed or physically perforated. Chicken, mackerel, and the skin of beef tongue; the fat of beef heart and kidney; and the gelatinous surface of wieners are good examples of surface layers which normally inhibit water vapor transfer. During the terminal phase of the freeze-drying of chicken and pork products, heated shelf temperatures should be below 95F to prevent the melting of fat.

In many studies of meat dehydration, freeze-dried meat was used as a standard of perfection for comparative purposes. During the freeze-drying process, physical and chemical changes in meat are minimized because the structural components and chemically reactive compounds are rigidly locked in place by crystalline ice initially and because the structure does not change nor is liquid water available as solvent for chemical reactions at any time in the entire drying process.

Organoleptic evaluations of quality after rehydration and cooking were made on most of the products listed in the table on the right. The general observations were similar to those made on freeze-dried beef. The freeze-dried food could usually be differentiated from the frozen control and usually had a drier texture.

These studies illustrate the general applicability of the freeze-drying process to the production of high quality serving-size pieces of dehydrated meats, fish, and poultry.

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Freeze-drying of Serving-size Pieces of Meat, Fish, and Poultry

Food	Thickness	Plate temperature	Pressure	Drying time
	inch	°F	m.m.	hours
Beef shoulder steaks	3/4	113	0.10	19
Beef cube steaks	1/4	"	"	12
Pork steaks	1/2	"	"	12
Lamb shoulder chops	1/2	"	"	10
Veal shoulder chops	1/2	"	"	16
Beef T-bone steaks	1	113	0.15	22
Beef rib steaks	3/4	"	"	20
Beef round steaks	1	"	"	22
Pork chops	1/2	"	"	18
Pork steaks	1/2	"	"	16
Lamb chops	1/2	"	"	16
Beef heart	2	104	0.09	52
Beef tongue	1 3/4	"	"	52
Beef spleen	1	"	2	48
Beef kidney	2	"	"	48
Beef brain	1 1/2	"	"	48
Lamb heart	1 1/2	"	"	27
Lamb liver	1 1/4	"	"	23
Beef round steaks	1	107.6	0.20	20
Pork chops	1/2	"	"	12
Lamb chops	1/2	"	"	10
Smoked ham slices	1/2	120.2	.08	15
Skinless wieners	1	"	"	15
Luncheon meats				
Boiled ham	3/32	"	"	7
Bologna	1/8	"	"	7
Salami	1/8	"	"	7
Variety loaves*	1/8	"	"	7
Mackerel (whole)	1	98.6	0.09	33
Halibut steaks	1	"	"	25
Salmon steaks	1	"	"	25
Sea bass steak	1	"	"	25
Sole filets	1/2	"	"	17
Crabmeat (cooked pieces)	1/2	"	"	13
Chicken breast	1	95	.07	36
Chicken legs	1	"	"	36
Chicken thighs	1	"	"	36

* Three different beef-pork mixtures.

Properties of Freeze-dried Beef—*Biceps femoris*

Moisture content	3% after 24 hours in freeze-dryer
Structure	Like balsa wood. No volume change during freeze-drying
Color	Pink
Tristimulus Values	
Brightness	14–17%
Dominant Wavelength	591–592 mμ
Excitation Purity	29–32%
Rehydration 1 hour	80–90%
Organoleptic Observations	
Flavor	Same as frozen control
Texture	Generally drier than control
Appearance	Same as frozen control

***Left*—Vapor pressure—moisture content of freeze-dried beef. Temperature 100 F. *Right*—Reflectance spectra of freeze-dried beef.**