



Chapter 26 – Potatoes

Potatoes are grown commercially throughout the world, except in humid tropical lowland areas. They are one of the world's most important food crops and are traded as a commodity. This chapter refers to three basic types of potato, each of which has special considerations for stowage and carriage.

- Early/new or immature
- late/mature
- seed.

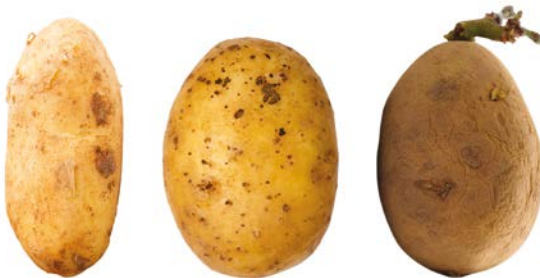


Figure 26.1: Three basic types of potato, left to right: early/new; late/mature; seed (notice fragile 'eyes' which produce new growth).

Early new potatoes have thin, relatively loose skins that are easily removed and damaged. Demand for this type of potato is significant and large quantities are shipped from Cyprus, Greece, Israel, Turkey and the Canary Islands during the northern winter and spring seasons.

Late/mature potatoes have firm skins and are, therefore, more resistant to damage and much easier to carry than immature potatoes.

Seed potatoes for shipment are small whole tubers, each with at least one eye to produce the new growth. Seed potatoes are grown under a regulated certification programme to ensure that they are as disease-free as possible.

26.1 Pre-shipment Considerations

Once potatoes have been harvested, they must be stored under optimal conditions until released for shipment.

High temperatures cause the tuber respiration rate to increase, using oxygen and food reserves, potentially resulting in excessive shrinkage. Freezing or chilling temperatures can damage and kill tuber cells. If the air surrounding the tubers has a low humidity, water will move from the tubers to the air, resulting in weight loss. Should the oxygen content of the air fall to a low level, cells within the tubers die and 'blackheart' forms.

Sprouting is a natural function of the tuber, but during shipment it is not desirable as quality and condition will suffer. Sprout suppressant chemicals or other methods may be used prior to shipment to prevent sprouting, but control in stowage can only be maintained by the correct temperature(s).

Potato tuber diseases may be the result of microorganisms, adverse pre-shipment storage conditions, or improper stowage and conditions of carriage. Potatoes are grown under the soil so, when harvested, will always contain spores of invading microorganisms on their surfaces. These will attack the tubers if the natural defence mechanism is ruptured. This can be as a result of mechanical damage, either during harvesting or subsequent handling, or may be the result of other forms of deterioration, such as sunscald. It may also happen if the tuber is subjected to wetting to a point that a film of water is present over its surface.



Figure 26.2: Signs of infestation by the potato tuber moth.

Some of the principal diseases found at the time of harvesting include:

- *Phytophthora infestans* (potato blight)
- a dry mealy rot due to species of *Fusarium* (dry rot)
- a bacterial soft rot principally caused by *Pectobacterium spp.*, formerly known as *Erwinia* (black leg)
- brown rot caused by the bacterium *Ralstonia solanacearum*
- ring rot caused by the bacterium *Clavibacter michiganensis subsp. sepedonicus*.

These are notifiable diseases in many countries.

Post-harvest deterioration, ie storage/stowage deterioration, will normally occur following the development of bacterial soft rot, usually the result of infection by *Pectobacterium* (formerly *Erwinia*) species. This causes collapse of the cells of the infected potatoes, releasing a heavily infected fluid. This gives rise, by contact, to soft rot developing in adjacent tubers. Over a period of time, the contents of whole bags may collapse into an unpleasant smelling slime.

Another cause of deterioration is infestation by insects. The two most serious pests of potato crops are the North American black and yellow striped Colorado beetle (*Leptinotarsa decemlineata*) and the potato tuber moth (*Phthorimaea operculella*).

It is necessary for shippers or charterers to provide phytosanitary certificates, attached to the B/Ls or other trade documents. These certificates are produced by the Authority of the country of origin and indicate that the specified consignment(s) have been inspected or treated according to the importing country's requirements.

While the Master should be able to rely upon a valid phytosanitary certificate, there is a continuing duty in relation to the cargo on board. For example, if infestation is noticed during the voyage, the Master/owners must take reasonable steps to deal with the situation.

Fumigation prior to berthing at an arrived port or, alternatively, rejection of a cargo of potatoes as a result of infestation or infection by serious bacterial diseases may cause massive delays to a ship and considerable problems for the shipowners.



Figure 26.3: Potato tubers infested with Colorado beetle.

Greening may occur in any part of a tuber exposed to light. Exposure to bright light during post-harvest handling, or longer periods (7 to 14 days) of low light, may result in the development of chlorophyll (greening) and bitter, toxic glycoalkaloids, such as solanine.

Experts advise that, while in cultivated varieties green discolouration of the flesh does not cause substantive harm to health, it will, depending upon extent, result in a loss of value of some of the cargo as green flesh tastes bitter and must be cut away before cooking.

When consignments are presented for shipment, the external condition of the packaging should be inspected. Evidence of wet patch staining of the bags, or any associated odours, should alert crew members to likely problems and the ship's P&I Club should be requested to appoint an expert surveyor to investigate and ensure that only healthy and undamaged potatoes are shipped.

Potatoes are often shipped in woven polypropylene bags of varying dark colours making it extremely difficult to recognise wet patches from superficial examination, so close inspection is recommended.

Mechanical damage, which is largely preventable, is one of the most significant factors affecting potato condition. Special care is essential during handling to and from the vessel, particularly when immature/new potatoes are being shipped. Bags of potatoes should not be walked over or handled roughly, with special care taken if palletised units of bags are overstowed by a second tier of pallets.

In light rain, snow or damp weather, cargo must be protected from moisture to preclude the onset of premature spoilage by bacterial soft rot. Potatoes should not be loaded or discharged during heavy rain.

26.2 Packaging and Stowage Considerations

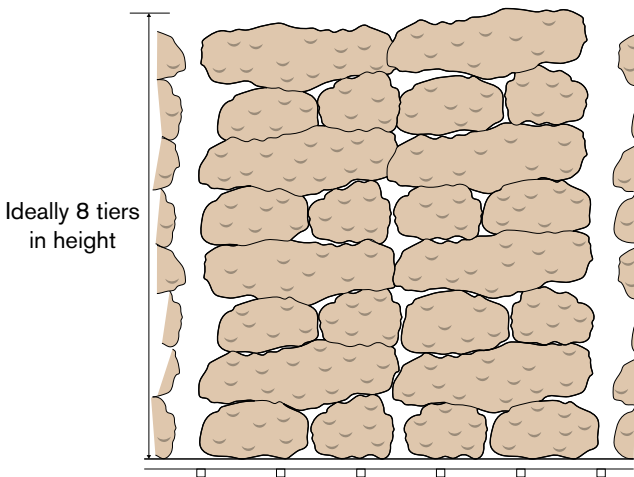


Figure 26.4: Potatoes packed in mesh bags.

Potatoes may be packed in hessian bags, woven polypropylene bags, sacks lined with an internal perforated polyethylene bag or, sometimes, cartons or crates. Various sizes of bags are utilised and each will usually contain about 25 kg of tubers. They are typically carried on pallets. Alternatively, potatoes may be packed in large open-top lift bags weighing some 2 to 3 T.



Figure 26.5: Potatoes packed in large open-top lift bags.

New potatoes are frequently packed in moist or dry peat moss. The main purpose of the moss is to protect the new tubers and to preclude skin-set to maintain their value. However, excess free water or release of water from the moss during carriage can cause problems that lead to bacterial soft rot of the tubers.

As for any product that may enter the human food chain, preparation of stowages will include ensuring that the cargo spaces are clean and dry. Potatoes are highly sensitive to odours and readily absorb foreign smells from chemicals, mineral oils and some fruits, etc. All compartments destined for stowage of potatoes must be free from odour and volatile substances.

Potato tubers are living organisms that consume oxygen and emit carbon dioxide, water and heat. The principal problem as far as stowage and carriage are concerned is the heat produced and, therefore, good climate control on board is essential to maintain the condition of tubers.

Condensation in the form of ship or cargo sweat should not be allowed to develop during a voyage. Long voyages demand more critical control than short-term voyages.

Table 26.1 sets out the approximate heat that may be produced by cargoes of potatoes. From these figures, it is evident that new/immature potatoes produce considerably more heat per 1,000 kg than late/mature potatoes and so should be considered more difficult to carry.

Type of potatoes	kcal per 1,000 kg per 24 hours				
	At °C	5°	10°	15°	20°
Immature		735	1,070	1,380	1,930
Mature		370	520	550	735

Table 26.1: Approximate heat produced by potato cargoes.

When potatoes are presented for loading in bags, stow heights of up to 8 tiers are preferable. To ensure adequate ventilation of cargo blocks, a maximum stow height of 12 bags should not be exceeded. The stowage must be arranged to ensure a free flow of air throughout the compartments.

Bags shipped on pallets are usually stacked to a height of 8 or 9 bags and are often secured to the pallet baseboards by nylon netting. Care must be taken (particularly when the bags are constructed of woven polyethylene) to ensure that the contents of pallets are fully and properly secured. The frictionless nature of this type of outer bag frequently results in the pallet loads becoming deformed and, in some cases, detached from the baseboards. This slippage may result in additional stevedoring costs for remaking the pallets.

Slippage of woven polyethylene bags from pallets, and also when loose stowed, into ventilation channels will cause restriction of airflow and must be prevented by the use of timber dunnage or dunnage nets.

26.3 Stowage in Refrigerated Cargo Vessels

Written instructions for the carriage temperature regime should always be obtained from the shippers and should be complied with throughout the voyage. Transport temperatures must be such that respiration and weight losses due to evaporation are kept to a minimum.

The approximate lowest safe temperature for the carriage of potatoes is 4°C (39°F) and carriage is usually recommended at 4 to 5°C (39 to 41°F) at a relative humidity of 90 to 95%.

The exact stowage patterns adopted for potatoes will depend on the permanent air circulation systems incorporated in the vessel. Strict supervision of cargo stowage must ensure that airflow will be evenly distributed throughout the compartments for maintenance of optimal temperature control. Detailed records of cargo compartment/ flesh temperatures should be maintained throughout the transit period.

When potatoes are discharged from refrigerated stowage, they should, ideally, be landed to stores at a similar temperature to that of carriage. If cold cargoes are discharged into ambient warm humid conditions, there is a risk of condensation forming on the tubers and bacterial soft rot will ensue.

Some shippers/consignees will request the vessel to undertake a dual temperature regime during transit and require the vessel to slowly raise the temperature of the cargo to above the anticipated ambient dew point at the discharge port, commencing some two to three days before discharge is due to begin.

26.4 Stowage in Mechanically Ventilated General Cargo Spaces

The usual system adopted is to use block stowage with air channels around each cargo block. This system relies on convection cooling. The cargo is stowed clear of the deck either by placing it on double dunnage or alternatively on pallet boards.

Cargo blocks should normally not exceed 3 by 3 m square. Smaller blocks may be preferred under certain circumstances, but stability of each block is critical and, when loose stowed, bags must be key-stacked to construct a locking stow precluding slippage or collapse of bags into the air channels, potentially causing a breakdown in the air circulation.

High stows may not only cause compression damage/bruising to the potatoes (particularly new/immature tubers) but may also result in excessive heating due to metabolic processes. Bags should be stowed ideally to 8 tiers in height, but never more than 12 tiers. The width of the air channels around the cargo blocks should be approximately 20 to 30 cm, constructed using dunnage and/or the locking stow noted above.

Cargo should be stowed clear of transverse bulkheads and ship's sides to promote air circulation, with exposed steelwork protected by paper mats or other sheeting to prevent condensation damage.

Potato cargoes should be kept well clear of engine room bulkheads and any other local heat sources situated on the vessel.

The stowage on any vessel should be designed to suit the type of permanent ventilation system fitted. Potato cargoes make heavy demands on ships' ventilation systems and a capacity calculated on the basis of at least 15 air changes per hour in an empty hold is required. At these rates, the ventilation system should be run continuously except when weather and climatic conditions prevent it, eg if there is a risk of shipping water through the weather deck ventilators or condensation forming on the cargo or internal ship's structures.



Figure 26.6: Blackheart is formed when the oxygen content of the air falls to a low level.

At higher rates of air changes per hour, consideration should be given, particularly on longer voyages, to either running the fans at lower power (reduction of speed) or for shorter times (ventilate intermittently) to maintain humidity and preclude water loss from the tubers (desiccation).

Details of ambient air wet and dry bulb temperatures, hold air wet and dry bulb temperatures, flesh temperatures, and the ventilation regime undertaken must be recorded in a dedicated ventilation logbook or, alternatively, the deck logbook.

26.5 Stowage in RoRo Vessels

Cargoes of new/immature potatoes are sometimes shipped in the holds of RoRo vessels. Packed in woven polypropylene bags and shipped on pallet boards with bags secured by nylon nets, losses and/or additional costs have been experienced due to the displacement of bags from the pallet boards.

The problem of tuber greening has also been experienced due to the practice of keeping the RoRo deck lights illuminated throughout the voyage. Attempts to prevent this have included covering stowages with polythene sheets, which unfortunately reduces the effectiveness of the hold ventilation system.

Hold lights should never remain continuously illuminated throughout a voyage, even of short duration.



Figure 26.7: Greening occurs when tubers are exposed to bright light or long periods of low light.

26.6 Transport of Potatoes in ISO Containers

Cargoes of potatoes may be carried in fan-assisted ventilated containers, open-sided containers, insulated refrigerated containers and 'porthole' insulated containers. For voyages of short duration, closed cargo containers may be used, but the doors should remain open whenever possible to promote ventilation. Stowage on deck must include provisions to protect the cargo from rain, sea spray and sunlight.

Flat racks are also used for below-deck stowage in well-ventilated compartments. Provisions should be made to afford exposed bags protection against rain and sunlight prior to loading and subsequent to discharge.

26.7 Seed Potatoes

Seed potatoes are usually shipped in smaller consignments than new or mature potatoes. The value of seed potatoes is much greater than potatoes destined for consumption and special care should be taken as any loss in quality or condition will potentially result in substantial claims. They may be carried in mechanically ventilated stowage, but for longer voyages involving any prolonged period in warm climatic conditions (defined as in excess of 20°C), they should be carried under refrigeration at a temperature of 3 to 4°C. This slightly lower temperature (compared to other potato carriage) ensures better sprout and weight loss control. Furthermore, seed potatoes stored at this temperature require less ventilation than potatoes stored at a higher temperature, as less heat is generated through respiration.

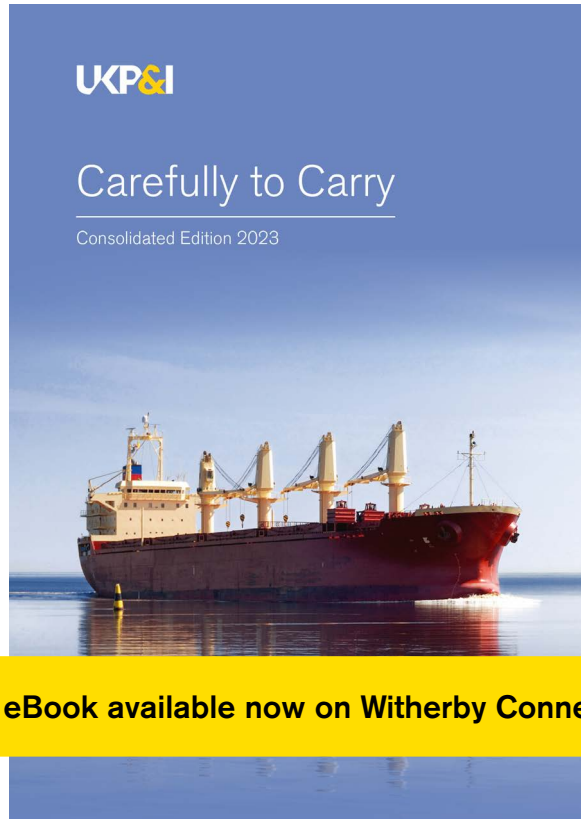
26.8 Safety

Inadequate, or failure of, ventilation in spaces containing cargoes of potatoes can cause life-threatening concentrations of carbon dioxide and oxygen depletion.

Before entry, the compartment(s) must be fully ventilated and a gas measurement conducted to verify the space is safe for entry. As per the *Code of Safe Working Practices* 2015, as amended 2022, the oxygen content must be at least 20% by volume.



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