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Question 8

Where should one store a soft cake, crunchy cookies, or a fresh bun with a crunchy crust in order to keep them fresh and crunchy for as long as possible: in

- A a tin can,
- B a plastic box,
- C a plastic bag, or
- D a paper bag?

Help: What happens when one leaves these items open in a room for a couple of days? Why does this happen?

Answer:

Crunchy cookies lose a lot of water during baking so that they contain less water than they would in equilibrium with typical indoor humidity (40-70% rh) (see movies [sensor introduction](#) and [cookies](#)). If we leave the cookies in contact with ambient air, then the cookies take up water until equilibrium is reached. As a consequence, the cookies loose their crunchiness and become soft. The opposite applies to the soft cake. Their dough contained so much liquid that even the fully baked cake has more water in it than it should in equilibrium with indoor air (see movie [inside a muffin](#)). Hence, a soft cake dries out and becomes hard when left out in the open. So, it is obvious that both, the soft cake and the cookies, should be stored in an air-tight container (this can be a tin can, a plastic box or a plastic bag). Of course, the soft cake and the cookies should not be stored together! See movie [a cookie and a muffin](#).

The situation with the bun is more complex. From the first part of this answer it should be clear that the bun itself is not in equilibrium with the ambient air with respect to water. The soft inner part contains more water and the crust contains less water than the water concentrations in equilibrium with the ambient air environment. See movie [inside a bun](#).

Obviously there is not much you can do to preserve this situation for a longer time. Inevitably water from the inside of the bun will migrate into the crust and



Movie: [sensor intro.](#)



Movie: [cookies](#)



Movie: [inside a muffin](#)



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make it soft while the inner part becomes drier. Freezing would be the best storage because it reduces the mobility of water to a minimum.

There also is the possibility to refresh old buns. For that purpose, you moisten the outside of the buns with water and then put them in a hot oven for a couple of minutes. Some of the water will migrate as steam to the inside of the bun and moisten it. The rest of the water will evaporate and leave a crunchy crust again.

The non-equilibrium between the thin crust and the moist inner part of the bun is so distinct that one would not expect this to develop or even exist for a significant length of time. How could this situation develop in the first place? The reason probably lies in an extremely low water conductivity of the dry crust which - once it has developed - serves as a barrier against any further migration of water molecules. The same can happen in dry soils where a dry surface layer can serve as an effective evaporation barrier.

[a cookie and a muffin](#)



Movie: [inside a bun](#)

