Lipid Vesicles Protect Enterovirus Particles, Enhancing Infectivity

When it comes to launching an infection, a chorus of viruses can prove more effective than soloists, according to Nihal Altan-Bonnet at the National Heart Lung and Blood Institute at the National Institutes of Health (NIH) in Bethesda, Md., and her collaborators. Although virologists long assumed that lone viruses independently infect target cells, in the case of poliovirus and other enteroviruses, several viral particles can cluster within lipid vesicles—from which they collectively enter target cells, improving overall infectivity and yields, the NIH researchers report. Details appeared 12 February 2015 in Cell (doi:10.1016/j.cell.2015.01.032).

Altan-Bonnet and her collaborators focused on poliovirus, a particular type of enterovirus. This group also includes rhinovirus, Coxsackie viruses, and enterovirus 68, which is linked to a recent outbreak leading to paralysis among some infected children.

In HeLa cells after replication and assembly, poliovirus congregates in clusters that are surrounded by double-membrane phosphatidylserine vesicles, ranging from 250 to 350 nm in diameter. Both rhinovirus and Coxsackie virus also form similar vesicles after infecting cells.

These steps take place within autophagosomes of the host cell, compartments that generally ingest and dispose of cellular debris when they fuse with lysosomes within a cell. However, when autophagosomes ingest poliovirus, the vesicles no longer fuse with lysosomes. Instead, the phosphatidylserine vesicles fuse with the plasma membrane of the host cell, and the viruses are released into the extracellular environment within this package, rather than as separate particles.

“It’s always been assumed that a cell plasma membrane has to burst to release enteroviruses, but poliovirus, rhinovirus, and Coxsackie virus leave without lysing the cell,” Altan-Bonnet says. A clear advantage to releasing packaged sets of viruses is that the vesicle-transported polioviruses are sixfold higher in infectivity, and replication rates are higher than those of free polioviruses in infected cells. Moreover, because the RNA-based genomes of enteroviruses are subject to a high mutation rate, the progeny sometimes produce defective proteins. However, there is a greater chance that at least some of the viruses mixed within each package will produce fully functioning
proteins, boosting the overall chances of survival.

Another advantage is that the membrane enclosing the viral particles likely protects them from detection by the host immune system, according to Al-Bari Aldo Moro, Bari, Italy. "These techniques are also by the dough fermentation technology to allow virus replication," he suggests.

These broad findings “provide clear evidence that viruses have evolved mechanisms to facilitate transmission of groups of viruses,” says Raul Andino at the University of California, San Francisco. Genetic complementation and recombination could produce a reservoir of evolutionary inventions that favor viral infection. “A larger number of viral genomes and higher gene doses could neutralize host innate responses and remodel the cell architecture to allow virus replication,” he says.

Carol Potera is a freelance writer in Great Falls, Mont.

NEW IN ASM JOURNALS

Organic Durum Wheat, Sourdough-Fermented Bread Called “Best”

David C. Holzman

“Sourdough bread made with organic durum wheat flour has better technological and nutritional features,” says Raffaella Di Cagno of the University of Bari Aldo Moro, Bari, Italy. “These characteristics are influenced not only by the quality of the materials used, but also by the dough fermentation techniques.” Sourdough fermentation is the oldest method for leavening bread, going back to at least 1500 BC, based on Egyptian mural paintings, she points out. Details appeared in Applied and Environmental Microbiology (doi:10.1128/AEM.04161–14).

Di Cagno and her investigators, all from Italian institutions, compared sourdoughs from wheat grown following different agricultural approaches—organic made from wheat fertilized with manure and with weeds pulled manually, from conventionally grown wheat to which herbicides were applied, from wheat grown using green manure, that is, reliant on nitrogen from legumes, and from wheat grown without applied fertilizers or herbicides. Ironically, bread made from the latter, no-input wheat had the best “technological” properties, according to Di Cagno. However, without fertilizers, that wheat field had low yields, she says.

The technological properties of bread encompass its structural and sensory qualities, according to Di Cagno. Sourdoughs made from organic wheat flour bested those of their conventional counterparts, she says. “In particular, specific volume, crumb structure, and crust color of breads made with organic sourdoughs were optimal. Breads from manure-fertilized organic wheat also have better technological properties than those fertilized with legumes. The breads from wheat fertilized with manure also have the greatest nutritional content. For instance, they produce more phytase, which hydrolyzes phytic acid, releasing calcium, magnesium, iron, zinc, and phosphate.

Greater microbial diversity also improves the nutritional content of sourdoughs from organic wheat, says Di Cagno. “Each species may contribute, in a different way, with its own metabolism to the final sourdough bread features.” For example, a greater diversity of lactic acid bacteria raises levels of extractable phenolic compounds, including ferulic acid, caffeic acid, and sinapic acid, all of which have anti-oxidative, anti-inflammatory, and anti-carcinogenic activities, she says.

Before fermentation begins, the dough made from conventionally grown flour had the highest bacterial diversity, according to the report. Proteobacteria such as Pantoea and Pseudomonas appeared mainly in the organic and no-input flours, and Pseudomonas is a nitrogen fixer, which is important in the organic soils, according to Di Cagno and her collaborators. The biodiversity of Firmicutes is greatest in the organic breads—especially that made from flour from the no-input wheat. More generally, lactic acid bacteria “completely and stably dominated” the mature sourdoughs, they note.

Not all technological features are superior in bread made from organic

MINITOPIC

Water-Based “Nanostructures” Inactivate Pathogens

Water vapor, when sprayed through specialized equipment containing concentric electrodes, can yield “water nanostructures” that can inactivate bacteria, including foodborne pathogens such as Escherichia coli and Salmonella enterica on foods such as fruits and vegetables and on stainless steel surfaces, according to Philip Demokritou of the Harvard School of Public Health in Boston, Mass., and his collaborators. These structured aerosols contain droplets that are 25 nm in diameter, remain airborne in indoor conditions for hours, contain reactive oxygen species, and have a very strong surface charge, the researchers note. “This novel, chemical-free, and environmentally friendly intervention method holds potential for development and application in the food industry, as a ‘green’ alternative to existing disinfection methods.” Details appeared 19 February 2015 in Environmental Science & Technology (doi:10.1021/es505868a).