American Forest & Paper Association

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TO: **Containerboard Sector**

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RE: **Research on Cleanliness of Multi-Use Reusable Plastic Containers (RPC) – Summary of Findings**

PURPOSE: To update the sector on research concerning the cleanliness of multi-use plastic containers (RPCs) used in the food industry.

BACKGROUND: A research program intended to investigate the cleanliness of multi-use RPCs has been completed. The program was conducted by third-party university professors and affiliated laboratories. The principle investigators were Dr. Trevor Suslow, University of California – Davis and Dr. Steven Ricke, University of Arkansas. The program included a field survey and controlled laboratory studies to investigate the following hypotheses:

1) Commercial methods of cleaning and sanitizing RPCs are unlikely to meet guideline levels for cleanliness;
2) Microbial biofilms can form on RPCs used in the food industry; and
3) Commercial methods for cleaning and sanitizing RPCs do not result in a surface void of microbial growth

DISCUSSION: To test the first hypothesis, a field survey was conducted. Sampling of RPCs was accomplished at one packing facility over the course of two weeks. The sampling included random collections from RPCs as well as "for cause" samples that showed visible contamination of soil or debris. The RPC sample size was sufficient (n=24 for random; n=10 for cause) to be considered statistically relevant. While I have been unable to locate regulatory levels for establishing levels of "cleanliness," the pass/fail levels used in the survey of 1,000 (3 log) bacterial colony forming units (CFU/sample or RPC) are generally consistent with guideline values for food contact surfaces that I had found in the literature (FSAI, 2006; NSW, 2014). A 20% failure rate was also used in the survey. The results of the study showed a broad range of indicator organisms as CFU/sample on the surface of the RPCs. The summary findings are: 1) over 30% of RPCs exceeded the cleanliness benchmark of 1,000 CFU/sample or RPC; and 2) the "for cause" samples did not always predict the highest levels of bacteria.

This second point is important as common practice uses a visual determination of cleanliness. This study indicates that more objective and quantitative inspections including microbial evaluation are required beyond simply visual inspections to accurately determine the cleanliness of RPCs.

To test hypothesis 2, bench scale screening studies were performed. The basic objective was to determine if specific bacteria would adhere and produce biofilms on RPC surfaces following inoculation to a mixture of bacteria. Based on observations using scanning electron microscopy (SEM), it was determined that biofilms consistent with the organisms in the mixture were formed on the RPC surface.

To test hypothesis 3, RPC surfaces were inoculated with bacteria and biofilms were allowed to form. Several cleaning options were chosen to evaluate if chemical treatments could remove these biofilms from the RPC surface. While limited information is available on commercial cleaning of RPCs, this study used common food surface cleaning chemicals including detergent, quaternary ammonium compounds, and chlorine (bleach) solution. USDA recommends bleach solutions of 50-200 ppm for food surface cleaning. This study used the upper end of that range, 200 ppm. SEM results showed that none of these options completely removed the biofilm from the RPC.

Next, physical scrubbing was added to the protocol to determine whether it would remove an inoculated biofilm. RPC surfaces were swabbed three times to mimic a scrubbing action. The swabs and the RPC surfaces were evaluated for the presence of the bacteria. While the swabs were successful in removing some bacteria from the RPC surfaces, organisms continued to remain on the RPC after repeated scrubbing.

The final activity that was completed was a literature review to determine the possible pathogen transfer risk from food contact surfaces to food. Several authors have stated that the presence of biofilms was a relevant risk factor for the potential of food contamination. However, there are a limited amount of references available for actual evidence of biotransfer, and none were located for RPCs. Two references were discussed in the Arcadis summary: 1) Danyluk, 2012, reported biotransfer from inoculated paperboard packaging to food in conditions consistent to observations noted for RPCs, basically wet environments; 2) Mattos de Oliviera et al., 2010, reported that high levels of *Listeria* on stainless steel surfaces were readily removed indicating that the biofilm may be sloughing off, resulting in a potential for more widespread microbial transfer.

The research provided evidence to support the three hypotheses. In addition, information was presented that could be considered consistent with the ability of bacteria to be transferred from RPC surfaces to food.

REFERENCES

Food Safety Authority of Ireland (2006) 3rd Trimester National Microbiological Survey 2006 (06NS3): Examination of the microbiological status of food preparation surfaces.

New South Wales Food Authority (2014) Environmental Swabbing: A guide to method selection and consistent technique. NSW/FA/FI170/1303