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10-hydroxystearic acid as a potential quantifiable marker of bacterial contamination in meats

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Abstract. 10-hydroxystearic acid (10-HSA) is the major oxygenated derivative of oleic (cis-9-octadecenoic) acid, a monounsaturated n-9 fatty acid (MUFA). The corresponding metabolic reaction, which can be classified as both oxidation and hydration (addition of a water molecule to an isolated double bond), is mainly catalyzed by oleate hydratase (OhyA), a member of flavoenzyme family, These enzymes, classified as hydro-lyases (EC 4.2.1.53) are of interest for industrial applications due to their role in the generation of hydroxy fatty acids, which are used in surfactants, lubricants, and biodegradable polymers. 10-HSA, which can be further oxidized to 10-ketostearic (10-KSA) and 9,10-epoxystearic (9,10-ESA) acids, is produced only by bacteria, such as ruminant species (Selenomonas ruminantum, Enterococcus faecalis, etc) or multiple other bacteria (Staphylococcus, Bacillus, Listeria,, Pseudomonas) that live in various contaminated fresh meats (Radka et al, 2021). Porcine and trout meat do not naturally contain 10-HSA, but beef may contain 10-HSA, which is deposited from the rumen to meat and milk. The corresponding OhyA is not found in ruminant meat. The gene encoding OhyA is found in different bacteria and is involved in processes such as surviving stress, modulating membrane composition, etc. However, Pseudomonas aeruginosa that lacks OhyA, is using other enzyme systems, for example lipoxygenase (LoxA) (Morello et al, 2019). There are multiple chemical and biochemical markers of bacterial levels and activities in meat – pH, enzyme activities (such as of catalase or coagulase), metabolic end products (such as hydrogen sulfide, indole, ammonia, volatile organic compounds (VOC) like histamine). Total volatile basic nitrogen (TVB-N) is another quantifiable indicator of bacterial spoilage. The knowledge that 10-HSA is synthesized only by bacteria inspired us to investigate the utility of this oxylipin as a potential biochemical marker for assessing the level of bacterial contamination in meats. We investigated the formation of 10-HSA in minced porcine, bovine, and rainbow trout meat for 8 or 11 days at refrigerator temperatures by LC-MS/ToF and correlated the results with the CFU/g values obtained by enumeration of total microbial counts of mesophilic aerobic microorganisms and separately of Pseudomonas spp by ISO methods. Results: 10-HSA has a common linear positive correlation with bacterial counts for all three studied meats with R2 = 0.96 between 1 and 8 or 11 days. This phenomenon suggests the presence of various bacteria that may have slightly different slopes of the linear regression, the resulting correlation is a combination of these primary correlations. For Pseudomonas spp, there are separate positive linear correlations for all three meat types. Consequently, we can distinguish the meats by the slope of their regression line. Conclusion: These are the first encouraging results, but further research is needed to prove the suitability of 10-HSA as a novel marker of bacterial contamination of various meats.
Radka et al, 2021, J. Biol. Chem., 296, 100252. https://doi.org/10.1074/jbc.RA120.016818 Morello et al, 2019. Front. Microbiol., 10:1826. https://doi.org/10.3389/fmicb.2019.01826)

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