

# Dynamic changes of bacteria and screening of potential spoilage markers of lamb in aerobic and vacuum packaging

Xiangyuan Wen, Dequan Zhang, Xin Li, Ting Ding, Ce Liang, Xiaochun Zheng, Chengli Hou

*Institute of Food Science and Technology, Chinese Academy of Agricultural Sciences, Key Laboratory, of Agro-Products Quality and Safety Control in Storage and Transport Process, Ministry of Agriculture and, Rural Affairs, Beijing, China*

**Objectives:** Some microbes can consume the nutrients of fresh meat to produce a large number of undesirable volatile organic compounds (VOCs) with off-odors, such as alcohol, aldehydes, ketones, sulfur compounds, etc. (Mansur et al., 2019; Zareian et al., 2018). In addition to microbial activity, studies showed that meat could also affect VOCs profiles (Pavlidis et al., 2019). The related research on the potential volatile spoilage markers (VSMs) of lamb was very scarce although some non-volatile compounds and the ratio of some volatile aldehydes (such as hexanal/nonanal, octanal/nonanal, and hexanal + heptanal + octanal/nonanal) were reported as freshness indicators (Karabagias, 2018). Furthermore, exploring the relationship between bacteria and VOCs contribute significantly to revealing the spoilage mechanism and characterizing the freshness of fresh meat.

**Materials and Methods:** The two-sides *longissimus dorsi* muscles (LMs) were collected after carcasses were chilled at 0~4°C for 24 h and were randomly divided into aerobic-packaged (AP) and vacuum-packaged (VP) groups. Each LM was divided and the meat pieces were packaged respectively. The packaged samples were stored at 4°C. The TVC was determined according to Mansur et al. (2015). The TVB-N was measured referring to the China national standard of GB/T 5009.228-2016. Odor analysis was performed according to Mansur et al. (2019). The bacterial community was sequenced on an Illumina MiSeq PE300 platform/NovaSeq PE250 platform (Illumina, San Diego, USA). VOCs were extracted and determined according to Xiao et al. (2020).

**Results and Discussion:** During the storage period, total viable counts of aerobic microorganisms (TVC) and total volatile base nitrogen (TVB-N) of all samples showed an increasing trend, while sensory scores showed a decreasing trend. The TVC, TVB-N and odor score of lamb to the limit values (more than 7 log CFU/g, more than 15 mg/100 g and median value below 3 respectively) were all 10-d AP samples and 28-d VP samples. It indicated that the shelf life was less than 10 d for AP lamb and less than 28 d for VP lamb. The results of bacterial structure showed *Pseudomonas* were dominant in AP samples, followed by *Carnobacterium*, and *Lactococcus* and *Latilactobacillus* were dominant in VP lamb. The mainly detected VOCs were alcohols in AP lamb, alcohols and aldehydes in VP lamb. The potential VSMs were 1-octen-3-ol, 1-hexanol, nonanal, methoxy-phenyloxime, 2,3-octanedione, aceto- in and 1-pentanol for AP lamb; Acetoin, 1-hexanol, 2,3-octanedione, hexanoic acid, 1-octen-3-ol, nonanal, hexanal and 2,3-octane- diolin for VP lamb.

**Conclusions:** In chilled conditions, the shelf life was less than 10 d and *Pseudomonas* was dominant in AP lamb, and the shelf life was less than 28 d and *Lactococcus* and *Latilactobacillus* were dominant in VP lamb. Five volatiles (1-octen-3-ol, 1-hexanol, nonanal, 2,3-octanedione, and acetoin) were common potential VSMs to AP and VP lamb, two volatiles (methoxy-phenyloxime and 1-pentanol) were specific VSMs to AP lamb, and three volatiles (hexanoic acid, hexanal, and 2,3-octanediol) were specific VSMs to VP lamb. This research provides a prerequisite for the rapid detection of meat freshness based on VOCs.

## References:

- Karabagias, I.K., 2018. Volatile profile of raw lamb meat stored at 4 +/- 1°C: The potential of specific aldehyde ratios as indicators of lamb meat quality. *Foods* 7, 40-50.
- Mansur, A.R., Song, E.J., Cho, Y.S., Nam, Y.D., Choi, Y.S., Kim, D.O., Seo, D.H., Nam, T.G., 2019. Comparative evaluation of spoil- age-related bacterial diversity and metabolite profiles in chilled beef stored under air and vacuum packaging. *Food Microbiology* 77, 166-172.
- Mansur, A.R., Tango, C.N., Kim, G.H., Oh, D.H., 2015. Combined effects of slightly acidic electrolyzed water and fumaric acid on the reduction of foodborne pathogens and shelf life extension of fresh pork. *Food Control* 47, 277-284.
- Pavlidis, D.E., Mallouchos, A., Ercolini, D., Panagou, E.Z., Nychas, G.-J.E., 2019. A volatilomics approach for off-line discrimina- tion of minced beef and pork meat and their admixture using HS-SPME GC/MS in tandem with multivariate data analysis. *Meat Science* 151, 43-53.
- Xiao, X., Hou, C., Zhang, D., Li, X., Ren, C., Ijaz, M., Hussain, Z., Liu, D., 2020. Effect of pre- and post-rigor on texture, flavor, het- erocyclic aromatic amines and sensory evaluation of roasted lamb. *Meat Science* 169, 108220-108227.
- Zareian, M., Bohner, N., Loos, H.M., Silcock, P., Bremer, P., Beauchamp, J., 2018. Evaluation of volatile organic compound release in modified atmosphere-packaged minced raw pork in relation to shelf-life. *Food Packaging and Shelf Life* 18, 51-61.

**Key words:** Lamb, Dominant bacteria, 16S NGS, HSPME GC MS, VOCs