

Effects of culture temperature of chicken satellite cell on production yield and taste characteristics for cultured meat

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Muscle satellite cell is myogenic stem cell which have capacity to regenerate damaged muscle though proliferation and differentiation to muscle fiber and is main cell source for cultured meat. In this study, optimal culture temperature was investigated to high yield and better taste characteristics of cultured meat using chicken satellite cells. Primary cells were isolated from 19 embryonic day chick embryo's hindlimb muscle and satellite cells were purified by pre-plating technique. The purified cells were cultured at 37, 39, 41 and 43°C in 5% CO₂ and proliferation ability was determined by the percentage of 5-ethynyl-2'-deoxyuridine (EdU) positive cell, cell counting Kit-8 (CCK-8) assay and population doubling time (PDT). The satellite cells were differentiated for 3 days at 37, 39, 41 and 43°C and the Fusion Index (% of nuclei within MHC+ myotube) and Myotube Formation Area (% field area coverage of myotube) were measured for the level of differentiation of satellite cell. To harvest chicken cultured muscle tissue (CMT), the satellite cells were cultured on 175T flask at 37, 39, 41 and 43°C for 3 days after differentiation. Total amino acid and free amino acid related to umami compounds (glutamic and aspartic acid) of the CMT were measured by amino acid analyzer. Finally, taste characteristics (sourness, bitterness, umami and richness) of the harvested CMT were evaluated by electronic tongue system.

As the results, proliferation ability of satellite cell is robustly related to production yield and cost for cultured meat and the level of differentiation to myofiber is critical parameter to meat quality for cultured meat. The proliferation ability of satellite cell at 41°C was significantly ($p < 0.05$) higher than those of other culture temperatures. Also, Fusion Index and Myotube Formation Area shows significantly ($p < 0.05$) higher compared to other temperature groups. It has been reported that proliferation and differentiation ability of satellite cell vary by culture temperature, and depends on animal species, muscle types and ages. For this reason, the optimal culture temperature of satellite cell should be identified in consideration of the above factors for fabrication of high-quality cultured meat. This study clearly shows that satellite cell derived from chicken embryo increased their proliferation and differentiation ability when cultured at 41°C and it implies that chicken satellite cell culture at 41°C can improve the productivity and quality for cultured meat. Meat is one of the protein-rich foods and the amino acid contents in meat is critical factor for nutritional value and sensory taste. Therefore, it is principal key for cultured meat to imitate above factors of conventional meat. Total amino acid contents of chicken CMT at 41 and 43°C were significantly ($p < 0.05$) higher compared to those at 37 and 39°C. It is considered that differentiation ability of chicken satellite cell is affected on the temperature, thereby the amino acid contents in CMT had difference by culture temperature. Umami taste is known to enhance the palatability of foods and elicited by free glutamate and aspartate in meat and can be boosted with synergistic effect when glutamate is interacted with 5-nucleotide such as inosine monophosphate (IMP) and guanosine monophosphate (GMP). Free glutamic acid in CMT at 41°C was significantly ($p < 0.05$) higher than those at 37°C but, the aspartic acid was no significant ($p > 0.05$) difference among the temperature groups. Furthermore, there was no significant difference ($p > 0.05$) in sourness and bitterness in CMT. As the culture temperature increase, however, the umami strength in CMT significantly ($p < 0.05$) increased on the temperature. The richness in CMT was significantly increased ($p < 0.05$) from 37° to 41°C, the richness at 43°C was significantly ($p < 0.05$) decreased compared to 41°C. It is considered that the difference in the relative strength of umami taste on culture temperature is due to the difference in free glutamate contents in CMT on temperature. In addition, it is believed that ATP content in CMT have difference according to differentiation ability on temperature and the Umami in CMT was increased by IMP GMP converted from ATP, that enhanced Umami strength by synergizing with glutamate. Consequently, this result suggests that the optimal culture temperature of satellite cell for chicken cultured meat tissue is 41°C.

Key words: Cultured meat, Muscle satellite cell, Culture temperature, Cultured meat taste, Cultured muscle tissue