CHAPTER FIVE

CONCLUSION AND FUTURE WORK

5.1 Conclusions

According to Section 2.1 of this project, we were unable to synthesize the α-quaternary amino acid as no product was formed under Kolbe reaction with several essential objectives. The goal involved the synthesis and characterization of reaction intermediates, optimization of reaction conditions, and analysis of the mechanism. The outcomes of these objectives are summarized in the following subsections.

5.1.1 Preparation and Characterization of Reaction Intermediates

The production of α-quaternary amino acids required key intermediates to be prepared using electrochemical reaction and radical coupling activities. However we were not successful in the synthesis of HO005(α-quaternary amino acids). The 1H NMR spectrum of HO005 gave peaks similar to the compound Methyl 2 acetamidoacrylate. Analysis of the structure using complementary 13C NMR spectroscopy also revealed structure similar to Methyl 2 acetylamidoacrylate. The GC-MS analysis of samples (HO001–HO005) indicated that the expected base peak at m/z 142.20 was consistent across the samples. Nonetheless, multiple peaks and the appearance of high molecular weight fragments

(m/z 171–355) demonstrated side products and incomplete reaction, requiring further purification.

5.1.2 Mechanistic Insights and Process Modeling

The postulated mechanism incorporates carboxylate formation, and radical coupling, however amine addition was not achieved, so no α-quaternary amino acid was formed.

5.2 Future Work

Future efforts to overcome the identified limitations in order to obtain a higher yield, purity and scalability of a-quaternary amino acid synthesis would be addressed in future work as has been concluded in Section 4.1. It is proposed to follow the following steps:

Better Purification Methodologies: The residual TBABF4 and side products render the utilization of advanced purification to be urgent. Column chromatography of solvent gradients could reach purities of over 90 percent or high-performance liquid chromatography (HPLC). Also, the exposure to alternative workup solvents (such as dichloromethane or ethyl acetate) could minimize the contamination with electrolytes further.

Stereochemical Analysis: The stereochemistry and enantiopurity of the products should be ascertained to be useful in pharmaceutical synthesis. Stereochemical products of the radical coupling reaction are to be confirmed with the help of such methods as chiral HPLC or X-ray crystallography.

Electrode Optimization: The observed electrode passivation process suggests the necessity to consider alternative electrode materials which may be more durable and have lower overpotential like the reticulated vitreous carbon. Surface modification techniques could also be used in mitigating passivation like coating with conductive polymers.

Platinum cathode and platinum anode that could provide higher durability and lower overpotential. Passivation could also be reduced by surface modification, e.g. coating with conductive polymers.

Reaction Condition Improvement: It is desirable to optimize the systems of base and electrolytes further. Mixed base system (e.g. KOH and $NaHCO_3$) has a potential to balance yield and selectivity and more research may be done to determine best ratios. The use of other conducting salt, e.g. $LiClO_4$, might enhance the conductivity and extraction efficiency.

Scalability Studies: In order to scale up the synthesis, batch-to-continuous flow electrochemical system ought to be explored. Flow reactors may increase the control of the reaction, minimize the side product formation and improve the reproducibility to the industrial purposes.

These steps to the future are designed to overcome the present shortcomings of purity, selectivity and scalability and continue on the successful history of the demonstration of a-quaternary amino acid generation by the Kolbe reaction. These advancements are well founded on the mechanistic knowledge and optimization techniques that were developed in this project.

5.3 Self-Reflection of the Project.

The project was also a significant milestone in my research and academic life as I got high-level laboratory and analytical skills. The work with electrochemical systems was not an easy task but very entertaining because of mastering new activities like, current control, and working with electrolytes that are very sensitive. The identification of the complex 1H and 13C NMR spectra along with the GC-MS data helps me a great deal in developing my analytical skills. Reaction design and optimization enabled me to learn how to apply systematic experimentation to attain reproducible results. Writing, especially developing a detailed report was an even bigger challenge which enhanced my skills in describing sophisticated scientific results. However, the obstacles that I surmounted (e.g., the control of the electrolyte contamination and the side reactions) could not reduce the giant rewards of the project. My work in a laboratory with Dr Anas as the supervisor of my research and interactions with the research community reaffirmed my desire to pursue synthetic chemistry and electrochemical methods.