

## RESUMEN

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En la presente tesis, se investigó la síntesis de ésteres metílicos de ácidos grasos mediante la transesterificación catalítica empleando aceite de soja refinado y materias primas ácidas de bajos costos. Se evaluó el comportamiento de diferentes compuestos de zinc con propiedades ácido-base, en términos de actividad y estabilidad en el medio de reacción.

En primera instancia se estudiaron las sales laminares hidroxiacetato e hidroxinitrato de zinc. El hidroxinitrato de zinc presentó buenos resultados en términos de actividad y estabilidad en la transesterificación de aceite de soja a 100° C, posibilitando su uso en ciclos catalíticos consecutivos, mostrando además una buena tolerancia al contenido acuoso. Hidroxiacetato de zinc presentó baja estabilidad en el medio de reacción.

A continuación, se evaluó el potencial catalítico de los carboxilatos de zinc, con diferentes longitudes. Las sales de zinc de ácidos grasos de cadenas largas mostraron elevados rendimientos con buena estabilidad y tolerancia al agua, con la posibilidad de uso en reacciones consecutivas. Estos compuestos se solubilizan en el medio de reacción a la temperatura de trabajo, y se recuperan fácilmente debido a que cristalizan a temperatura ambiente. A temperaturas mayores, se observó la transformación de estos materiales a glicerolato de zinc en el medio de reacción.

Los resultados obtenidos en la esterificación de ácidos grasos, mostraron que las sales carboxílicas de zinc presentan buena actividad. No obstante, se evidenció que durante la reacción se produce un intercambio de ligandos carboxilatos entre la sal carboxílica y el ácido a esterificar. Así mismo, la transesterificación de materias primas con 10-22 % de ácido oleico, mostraron que el oleato de zinc es capaz de esterificar los ácidos grasos libres y transesterificar triglicéridos en forma simultánea, con una notable actividad y selectividad.

El desarrollo de esta tesis también incluye el estudio del glicerolato de zinc como potencial catalizador. Esta sal mostró ser activa, selectiva y estable en la transesterificación de aceite de soja refinado, y además presentó buena tolerancia a la presencia de agua. El uso del glicerolato de zinc en la transesterificación de materias primas ácidas, presentó una notable actividad con un máximo rendimiento a FAME a tiempos de reacción cortos. Este resultado se debe a la formación en el medio de reacción de un sistema catalítico altamente eficiente (glicerolato/carboxilato de zinc), que opera en condiciones de reacción moderadas con elevada actividad y selectividad.

## ABSTRACT

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In the present thesis, the synthesis of methyl esters of fatty acids by catalytic transesterification using refined soybean oil and low-cost acid raw materials was studied. The behavior of several zinc compounds with acid-base properties were evaluated in terms of their activity and stability in the reaction medium.

First, the layered salts zinc hydroxyacetate and hydroxynitrate were studied. Zinc hydroxynitrate exhibited good results in terms of activity and stability in the transesterification of soybean oil at 100 °C, being possible to use it in consecutive catalytic cycles, also showing good tolerance to aqueous content. Zn hydroxyacetate presented low stability in the reaction medium.

Then, the catalytic potential of zinc carboxylates with different chain lengths was evaluated. At 100 °C, the zinc salts of long-chain fatty acids showed high FAME yields with good stability and tolerance to water, with the possibility of reuse. These compounds dissolved in the reaction medium at low operating temperature, and can be easily recovered because they crystallize at room temperature. At higher temperatures, a transformation of the materials into zinc glycerolate was observed in the reaction medium.

The results obtained in the esterification of fatty acids showed that zinc carboxylic salts presented good activity. However, it was observed that during the reaction a carboxylate shift occurred between the carboxylic salt and the acid to be esterified. In addition, the transesterification of raw materials with 10-22 % oleic acids showed that zinc oleate can simultaneously esterificate the free fatty acids and transesterificate triglycerides, with notable activity and selectivity.

The development of this thesis also included the analysis of zinc glycerolate as a potential catalyst. This salt showed to be active, selective and stable in the transesterification of refined soybean oil, and it also presented good tolerance to the presence of water. The use of zinc glycerolate in the transesterification of acid raw materials exhibited a notable activity with maximum FAME yield at short reaction times. This result is a consequence of the formation of a highly efficient catalytic system (Zn glycerolate/Zn carboxylate) in the reaction medium, which operates under moderate reaction conditions with high activity and selectivity.

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