

ENZYMATIC DEGUMMING OF FEEDSTOCK'S (VEGETABLE OIL) FOR BIO-DIESEL – A REVIEW

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Abstract

GBiodiesel is one of the alternative energy outstanding on the forefront of energy business due to its biodegradability, renewability, an excellent lubricity in low-sulfur diesel, high cetane number, etc. Moreover, biodiesel production itself also shows the outstanding reduction in CO₂ generation drastically. Degumming is considered essential for purifying vegetable oils and producing a quality feedstock for biodiesel. Degumming removes contaminated phospholipids (phosphorus-containing lipids composed of diacylglycerol—a phosphate group—and a simple organic molecule) contained in crude vegetable oils and lowers the phosphorus content of the oil to less than 10 parts per million.

The feed oil (feedstocks) contain impurities unfavorable for biodiesel production, e.g., phosphorus, free fatty acid, moisture. These impurities not only contaminate in biodiesel product but reduce biodiesel yield as well. The feed oils were, thus, pretreated to remove phosphorus (degumming), free fatty acid (deacidification), and water (drying), before sent to transesterification. Some or all of these pretreatments were carried out, in order to investigate the influences of the respective pretreatments on the biodiesel yield and purity. Crude vegetable oils contain phospholipids, which must be removed from oil during refining process. For removing phospholipids following methods were used: water, acid, and TOP degumming and most important enzymatic degumming.

Keywords: *Enzymatic degumming, Bio-diesel, Phospholipids, Rapeseed Oil, Sunflower Oil, Refining Process.*

INTRODUCTION

The present work related to a method for producing fatty acid alkyl esters, such as fatty acid methyl esters (FAME) and fatty acid ethyl esters (Bio-diesel) with a low level of impurities such as phospholipids (gums) from vegetable oil with the help of enzymatic degumming. Degumming is the pre-treatment of Feedstock's separation of gums, solid, water and free fatty acid. Technically, degumming is referred as an operation of purification of seed oil, which normally contain impurities in the colloidal state or dissolved in them. In more simple words, degumming is a process of removing the unwanted gums, which will interfere the stability of the oil product (like Bio-diesel). The aim of this article is the study of influence of enzymatic degumming on the amount of P, Mg and Ca in rapeseed and sunflower oil and other feedstock's (rich sources of phospholipids.) respectively.

Crude (feedstock's) oil contain variable amounts of non glyceride impurities, including free fatty acids (FFA),

nonfatty materials generally classified as “gums” or phosphatides, colour pigments, sterols, tocopherols, waxes, hydrocarbons, pesticides, and traces of metals. Most of these impurities, notably the phospholipids, are detrimental to colour; flavour, foaming, and smoke stability of the finished product and Phospholipids pose many problems for the storage and processing of the crude oil and must be removed by purification. However, for physical refining of vegetable oil, water degumming is not sufficient, so degumming process plays a critical role at physical refining of edible oil. Traditional degumming processes, including water degumming, super degumming, TOP degumming, acid treatment and other ones, cannot guarantee the achievement of low phosphorus contents required for physical refining, and they are not always optimally suited for all oil qualities because of the high content of NHPL (non-hydratable phospholipids) (Copeland et al. 2005). The latest degumming process is enzymatic degumming.

Three main degumming techniques (excluding Water degumming) have been developed: (i) acid degumming; (ii) acid-basic degumming; and (iii) soft degumming. Other processes such as dry, membrane and the present enzymatic degumming. Acid degumming processes are generally carried out at elevated temperatures using high-shear mixers. Phosphoric acid is often used to make phospholipids hydratable; in this case, the side reaction (i.e., increased phosphorus content in the crude oil) can be suppressed either by using citric acid or by reducing both the acid concentration and the treatment time. In the super degumming process proposed by Unilever milder, temperatures are used in a multiple holding-step process, which makes the process rather complicated. However, the residual phosphorus content is generally below 30ppm, probably because of the increased phosphate hydration.

In acid-basic degumming processes, the oil is treated with a degumming acid and partially neutralized with a NaOH solution. The metal-phospholipids complexes are dissociated by a strong acid into insoluble metal salts and phospholipids in their acid form, which are still soluble in oil. By raising the pH with NaOH, the phospholipids are converted into Na salts, which are more hydratable and therefore more easily removed from the oil.

Among the other degumming processes, dry degumming is an acid degumming process that uses concentrated acid followed by mixing with bleaching earth. This process is limited to oils with low phospholipids contents. Membrane degumming consists of the formation of micelles when the oil rich in

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phospholipids comes in contact with hexane. The micelles are separated from the oil by ultrafiltration. However, in practice this process is costly in terms of capital and operating costs and has not found industrial application.

In soft degumming, the crude or water-degummed Soft degumming process involves a complete elimination of phospholipids by a chelating agent, such as ethylene diaminetetra acetic acid (EDTA), in the presence of emulsifying agent. Different kind of crude oils were degummed by Soft degumming method; the content of phospholipids in the treated samples of the oils studied was lowered approximately to 5 mg kg⁻¹. However, the high cost of EDTA could not allow use this method in industry (Choukri et al. 2001).

ENZYMATIC DEGUMMING

The goal of this paper is to analyze the effect of enzymatic degumming on reducing of phospholipids from crude oils (feedstocks).

The enzymatic degumming process was firstly reported in the 1990s by Roehm and Lurgi Degumming is an important part of refining process degumming with enzyme is a well-established Industrial process for the physical refining of vegetable oils. Principle of enzymatic degumming is to convert non-hydratable phosphatides (NHP) to hydratable phosphates.(HP) This facilitates gum removals. This process is most suitable for crude oils containing relatively low levels of phosphatides; with phosphatide-rich oil, a prior water-degumming step is recommended.

There are two types of phospholipids: hydratable phospholipids (HPL) and non-hydratable phospholipids (NHPL), and they are removed from oil by the degumming process. Most of the phospholipids in crude oil (feed stocks) are hydratable and can be removed by water degumming (Carelliet al. 1997). NHPL are not hydratable with water, can not swell and form gels or precipitate from oil (Szydłowska-Czerniak 2007). Removing of NHPL requires more complex process like enzymatic degumming Nowadays, two kinds of enzymes, such as Lecitase 10L (pancreatic phospholipase A2) and Lecitase Novo (microbial lipase), are used for oil degumming in the industry (Yang et al. 2006; Bo et al. 2006). Significant of Lecitase ultra Enzyme is Lecitase ultra enzyme was able to identify only the phospholipids as substrate and did not hydrolyze the triglyceride in enzymatic oil degumming system.

BENEFITS OF ENZYMATIc DEGUMMING

Compared to chemical and physical refining method The benefits of enzymatic degumming are:-

Higher Yields

A large amount of soapstock is produced by the commonly used process of refining, with caustic chemicals. Soapstock is the material produced by the neutralization of fatty acids in caustic refining, and there are large losses of oil during the separation of the soapstock. Very little oil is lost in the process

compared to the other methods due to the little water usage. The higher the content of soapstock, the higher the oil losses. The advantage of enzymatic degumming is that no soapstock is produced, and so there are no losses caused by soap stock separation. Generally speaking, more than 1% higher refining yields can be obtained by enzymatic degumming in comparison with the chemical method.

“Zero” Phosphorus Content

This has been verified by more than a year’s experience of enzymatic degumming at Southseas. They have been able to lower the phosphorous content in degummed soybean oil to less than 10 ppm (parts per million), even reaching levels as low as 3 ppm. This is comparable to the chemical process. After decolorization, the phosphorus content in the oil is reduced to virtually zero.

Environmentally Sound

The principle of enzymatic degumming is to convert non-hydratable phospholipids into hydrophilic lysophospholipids. Novozymes, in cooperation with some scientific institutes, is currently carrying out research into how to utilize these gum-like by-products. Conventional chemical oil refining produces a large amount of soapstock, which needs to be treated before disposal. The first step is acid-cooking using sulphuric acid. Water also needs to be added in the proportion of 10-15% of the total amount of crude oil. The resulting wastewater is acidic and needs to be neutralized using caustic chemicals. The whole process therefore requires large amounts of harsh chemicals with a potentially negative impact on the environment. In contrast, enzymatic degumming produces minimal wastewater because only 1-2% water needs to be added for efficient degumming. The wastewater actually contains lysophospholipids that can be recycled by mixing degumming water with oil seed meals or recovered by evaporation. In this way, enzymatic degumming becomes a refining process without waste products.. A low dosage of enzyme Lecitase ultra is added only 30g enzyme per ton oil. Enzymatic degumming is mainly focus on the development of new enzyme and optimal process for the reduction of phosphorus content Compared with the conventional chemical refining process, physical refining is becoming more and more popular. Enzymatic degumming with Lecitase Ultra is a special type of physical degumming that is proving to give good performance and higher oil yields.

CONCLUSION

Enzyme provides significant benefits in the simplified refining processes utilized during preparation of seed oil for biodiesel. These benefits include increased yield, reduced chemical usage, improved operating efficiency, and reduced waste by allowing a higher percentage of the vegetable oil feedstock to be recovered and converted to biodiesel.

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Enzymatic biodiesel synthesis can solve several problems posed by the alkaline-catalyzed transesterification but it has the drawback of being too expensive to be considered competitive. Costs can be reduced by lipase improvement, use of unrefined oils, evaluation of soluble/immobilized lipase preparations, and by combination of phospholipases with a soluble lipase for biodiesel production in a single step. As shown here, convenient natural tools have been developed that allow synthesis of high quality FAMES (EN14214) from unrefined oils in a completely enzymatic single-step process, making it ...Â biodiesel; lipase; enzyme improvement; crude oil; enzyme immobilization; transesterification; phospholipase; degumming. Enzymatic degumming of feedstock's (vegetable oil) for bio-diesel " a review.Â Moreover, biodiesel production itself also shows the outstanding reduction in CO generation 2 drastically Degumming is considered essential for purifying vegetable oils and producing a quality [Show full abstract] feedstock for biodiesel. Degumming removes contaminated phospholipids (phosphorus-containing lipids composed of diacylglycerol "a phosphate group"and a simple organic molecule) contained in crude vegetable oils and lowers the phosphorus content of the oil to less than 10 parts per million. The feed oil (feedstocks) contain impurities unfavorable for biodiesel production, e.g., ph Bio-diesel has become more attractive as an alternative fuel for diesel engine because of its environmental benefits and the fact that it is made from renewable resources such as vegetable oil and animal fats by reacting them with short chain alcohols.Â The effect of degumming on fuel properties of water degummed Linseed methyl ester and their different diesel blends are discussed in this paper. Keywords. Alkaline catalyst; Biodiesel; Degumming; Water degummed linseed oil; Transesterification.Â Bio-diesel or Vegetable oils also introduced the development of gumming, the formation of injector deposits, sticking as well as their compatibility with conventional lubricating oils. Plant oils contain highly variable amounts of gums.