EU imports grow

Used cooking oil (UCO) is increasingly utilised in the EU to produce biodiesel. To meet rising demand for this feedstock, EU imports of UCO from China, Indonesia and Malaysia are growing, raising concerns about their quality, traceability and indirect land use impact

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The utilisation of used cooking oil (UCO) as a biodiesel feedstock has increased significantly within the EU, which produced around 15,000M litres of biodiesel in 2017.

Between 2011 and 2016, there was a 360% increase in the use of UCO as a biofuel feedstock, rising from 0.68M tonnes to 2.44M tonnes in just five years, driven by renewable fuel policies.

To meet growing UCO demand, imports from outside the EU (predominantly Asia) are the only legitimate options for increasing supply. However, as there are no current globally agreed standards for UCO, suppliers are only required to meet the operator's specifications, resulting in a wide variety of qualities and chemical compositions.

The net imports of UCO and UCO-based FAME biodiesel (UCOME) to the EU have significantly increased since 2014, with a large proportion of this sourced from China, Indonesia and Malaysia. In 2018, these three countries exported more than 500,000 tonnes of UCO to the EU. This reliance is set to continue, with EU imports of Chinese UCO increasing by 5.6% in first quarter 2019, compared with first quarter 2018.

Factors affecting UCO quality

UCO has various names including waste cooking oil, used frying oil and yellow grease. However these all refer to the same commodity; purified oils and fats of plant and animal origin that have been used to cook food.

European UCO is deemed a waste that is no longer fit for human consumption, prompting its inclusion as an acceptable feedstock for 'double counting' towards the renewable fuel targets set out within the EU's Renewable Energy Directive (RED).

The fatty acid composition of edible oil feedstocks differs – often significantly – impacting their properties and suitability for biodiesel use. This is especially important when considering the properties of UCO; the characteristics of the initial edible oil used for frying will directly influence those of the waste product.

Additionally, the cooking conditions employed will also affect the quality of the UCO feedstock. This includes the number of times the oil has been used, the food types fried within it and the oil's storage between uses. During frying there are several chemical processes that take place, resulting in the deterioration of the oil. These include oxidation, hydrolysis and polymerisation.

The first major consideration of the UCO's properties relates to its saturated fat content. Higher concentrations of saturated fatty acids can result in a fuel that has operational issues at lower temperatures.

Another important consideration of UCO quality is the free fatty acid (FFA) content of the feedstock. FFAs are long carbon chain organic acids that have hydrolysed and become disconnected from the triglyceride backbone. These are therefore classed as impurities and must be removed before the transesterification process. Refined oil tends to have an FFA content below 0.5wt% which is ideal for biodiesel production. However in UCO, this can range between 0.5-15wt%. Without more sophisticated equipment, UCOs with FFAs above 3wt% can result in increased processing problems, producing soaps which effectively reduce the yield of the target methyl esters.

The FFA content of UCO can be greatly influenced by cooking practices, differing significantly between domestic and ▶

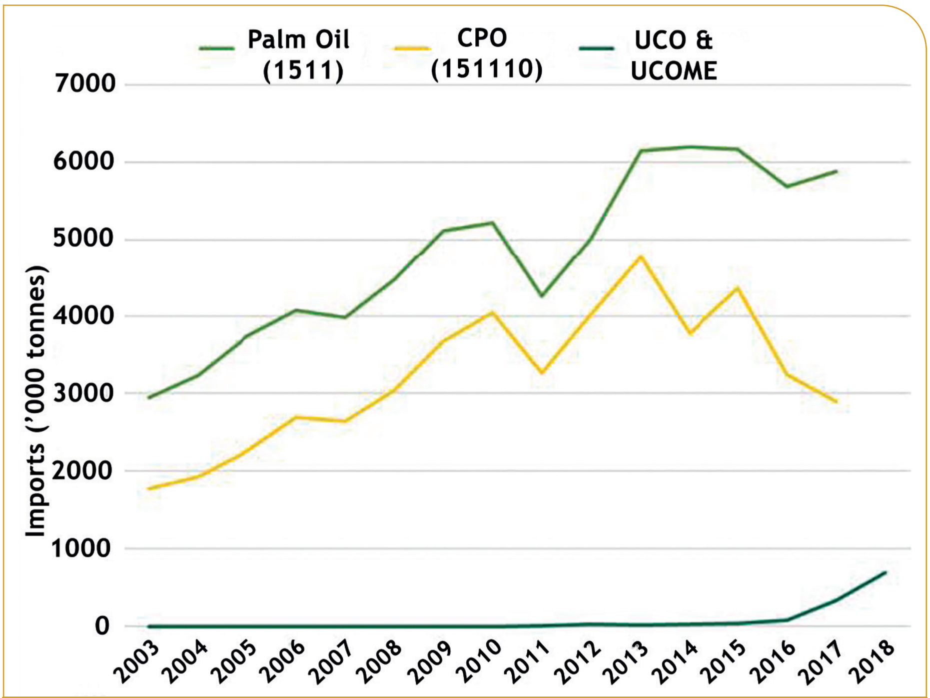

Figure 1: Net imports of palm oil, CPO and UCO/UCOME into EU ('000 tonnes)

Source: NNFCC

industrial sources. Increased frying time has been shown to cause degradation of the oil, increasing the UCO's FFA content. However, the deterioration can be exacerbated further by short batch frying processes. Intermittent cooking, involving the heating and reheating of the oil several times, increases the likelihood of oxidation and hydrolysis, impacting the quality when compared to continued frying. This also results in a more viscous and acidic UCO, which again can impact its suitability as a feedstock for biodiesel.

The different sources of UCO – both in the original raw material used and the cooking practices employed – results in a biodiesel feedstock that has the potential to be heterogenous.

Before UCO can be used as a biodiesel feedstock, it must first be cleaned to remove any impurities and solids that exist as a result of the cooking process. This includes sieving to physically remove solids, degumming to remove phospholipids and de-watering. In addition, deacidification is often required, with UCO tending to be more acidic than the original edible oil source. Pre-treatment is particularly important when considering the conversion of UCO into biodiesel; the produced fuel must meet EN14214 standards in the EU and ASTM D6751 in the USA.

The concentrations of FFAs in UCO can have a large impact on the transesterification reaction. If FFAs are in excess of 3wt%, then saponification (soap formation) can occur, causing a reduction in biodiesel yield while also increasing the catalyst consumption. In addition, the presence of water within the feedstock can lead to hydrolysis which will also affect the efficiency of the conversion process. Consequently, several different mechanical and chemical methods have been developed to reduce the FFA and water content, while also neutralising the UCO.

Once the UCO has been pretreated, the transformation of the waste feedstock into methyl esters is similar to that of virgin oils and fats – resulting in equivalent fuel properties. As with edible oil feedstocks that are high in saturated fats, any issues with crystallisation at low temperatures requires the addition of cold flow improvers to the produced UCOME to ensure its usability.

UCOME in the EU

There is already a well-established European UCOME market, with an estimated 3.5M tonnes of potential UCO capacity available within the EU.

Between 2011 and 2016, the utilisation of UCO increased steadily, resulting in a 360% rise in its use, from 680,000 tonnes to 2.44M tonnes. The prominent EU users of UCO are Germany, Italy, the Netherlands, Spain and the UK.

Up until 2003, UCO was utilised extensively as a high fat supplement in animal feed. However, the outbreak of mad cow disease (BSE) prompted the banning of UCO as a feed supplement, resulting in its classification as a waste. There are now legal limitations placed on the collection and disposal of UCO that have resulted in it becoming a well-regulated feedstock, attaining certain levels of quality.

In addition to this quality, the traceability and sustainability of the UCO generated in the EU – specifically the oil from where it originates – is well established.

As UCO is deemed no longer fit for human or animal consumption, the EU legally recognises it as a waste and its disposal is carefully regulated.

The default carbon intensity value of biodiesel produced from UCOME is currently defined at 14 gCO_2e/MJ, representing a carbon saving of 83% when used as a replacement to diesel.

In comparison, biodiesel from rapeseed, soya and palm oil have associated carbon intensity factors of 52, 58 and 68 gCO_2e/MJ, respectively, equating to carbon savings that range from 19-38%. These crop-derived feedstocks for biodiesel do not meet the 50% (latterly 60%) greenhouse (GHG) savings threshold required by the EU's RED. Therefore, when considering stated carbon intensity values, UCOME is seen as a preferable alternative fuel for reducing emissions.

The benefits of UCO also extend to the financial commitments of producing and supplying UCOME fuel. In the amended version of the RED (REDII), the use of waste feedstocks, including UCO, has been actively promoted by the European Commission, specifically their double counting towards renewable energy targets.

UCO and UCOME imports

Although the use of UCO is widely supported within the EU, particularly that produced by member states, there is a growing demand for it as a resource. This has resulted in the establishment of global UCO markets, although there are concerns about the quality, traceability and sustainability of imported UCO.

The EU has a well-regulated market for the use of the waste oil produced by member states; reputable companies collect UCO from industrial and commercial food producers, delivering the waste feedstock to biodiesel producers. As a result, 2016 estimates of the UCO market indicated that there was only a small amount of additional supply remaining within the EU. To meet the growing feedstock demand, global imports from outside the EU are the only legitimate option for increasing UCO supply. Net imports of UCO and UCOME into the EU have increased significantly since 2014 (*see Figure 1, above*), with a large proportion of the imports originating from China, Indonesia and Malaysia.

In 2018, EU UCO imports totalled more than 500,000 tonnes. Nearly 100,000 tonnes of this was sourced from

Figure 2: Price changes of UCO and CPO, 2017-2018 (US$/tonne)

Source: NNFCC

Malaysia. However, these bulk shipments were blends of both Malaysian and UCO originating from China.

In the UK, the most common feedstock source of the biodiesel supplied in 2018 – between April and December – was Chinese UCO, totalling 93M litres, representing 15% of certified biodiesel and 9% of the total certified renewable fuel. Furthermore, Malaysian UCO – which partially consists of blended Chinese UCO – accounted for an additional 36M litres of the UK's supplied biodiesel. Comparatively, during this same period, the UK's UCO feedstocks were used to produce 76M litres.

In addition to the increased deliveries of UCO, the EU imported nearly 200,000 tonnes of UCOME in 2018 sourced predominantly from Indonesia. Although biodiesel production from UCO is currently in its infancy in China, the country's hydrotreated vegetable oil (HVO) biodiesel capacity is increasing. For example, the ISCC EU certified Yangzhou Jianyuan HVO plant has a capacity of 100,000 tonnes/year, utilising UCO as its main feedstock. If China establishes a significant supply of EU certified biodiesel – using a double counting feedstock – then EU imports of Chinese HVO may increase significantly.

Trade data indicates that the EU is replacing its consumption of palm oil with global imports of UCO and, to a lesser extent, UCOME. This is due to the associated high indirect land use change (ILUC) impact of palm oil cultivation and the well-publicised issues with biodiversity.

Quality issues

The consumption of edible vegetable oils in China has grown significantly over the last decade. This has coincided with increased demand for fried food, with fast food restaurants – such as McDonald's and KFC – establishing themselves within the country. Domestic consumption of edible oils in China is met mainly by soyabean, rapeseed and peanut oils. However in large-scale, commercial food production – frying chips and other snack foods – palm is the preferred cooking oil. As a result, it is estimated that more than 40% of the palm oil consumed in China is used for food production, particularly in catering frying.

In addition, most of the edible oil consumed in Indonesia and Malaysia is sourced from domestic palm oil, particularly in Indonesia, where the use of palm oil in cooking has continued to increase, currently at a rate of ~5%/year. This equated to more than 2M tonnes of palm oil in 2016 alone.

Palm oil is high in saturated fatty acids, with a pour point of ~23.5°C. Therefore, any UCO originating from palm would have comparable fatty acid contents and chemical properties.

Due to the reliance on palm oil within their food industries, the UCO sourced from China, Indonesia and Malaysia is likely to fundamentally differ to that generated in the EU as a result of the differing original feedstocks. This could have repercussions, impacting the performance of the produced UCOME. Without the addition of cold flow improvers (CFIs), any biodiesel produced from UCO that originates from palm is likely to gel in colder temperatures, causing engines to fail.

Although routine quality testing is currently undertaken in Europe, this is by no means definitive. High-profile usability issues with biodiesel fuels could severely impact the public's perception and confidence in them, negatively affecting the broader biofuel sector in general.

An additional quality issue is the rancidification of UCO feedstocks. During the last decade, there have been several food safety scandals in China, with the most prominent relating to the supply and use of illegal cooking oil, often referred to as 'gutter oil'. The crudely processed waste oil – sourced predominantly from catering and sewage wastes – is sold for human consumption as a cheap alternative cooking oil. As part of a bid to improve food safety, the Chinese State Council has begun to tackle the mass production of illegal cooking oil, resulting in an increased supply of UCO.

There are currently no globally agreed quality standards for UCO, with the supplied feedstock merely required to meet the operators' desired specifications – this is normally <1% contaminants and <4% FFAs. UCO that is composed predominantly of gutter oil will contain much higher concentrations of FFAs and contaminants, causing issues in the production of biodiesel. The resulting higher processing costs and reduced yields associated with Chinese UCO may therefore result in an uneconomic process.

Sustainability issues

The key driver for biodiesel uptake has been its ability to markedly reduce the GHG emissions associated with the transport sector, particularly in helping the transition towards a decarbonised system. Biofuels that are produced in facilities which began operations after October 2015 are required to comply with a 60% GHG saving threshold, an increase from the previously mandated 50%.

Ensuring the sustainability of UCO feedstocks – correctly quantifying their potential for combatting climate change – is therefore imperative, particularly in relation to the obligations of fuel suppliers to reduce GHG emissions as part of the EU Fuel Quality Directive.

As a waste, UCO is considered a low risk ILUC biofuel feedstock. This differs to those produced from crops grown on arable land, such as palm oil, which is deemed high risk due to its increased ILUC implications. In the case of gutter oil – and other low-grade waste oil sources that are linked to animal by-products

– their validity as wastes is undeniable, falling in line with current EU policy and legislation, while their removal from human consumption supply chains will also help improve food safety in China. However, the inclusion of better quality, filtered oils that are not legally mandated as a waste is a more contentious issue.

In China, UCO has historically been an important component of animal feed, acting as a cheap and high energy additive, improving both the energy density and the binding of feed pellets. It has also been used as a supplement in creep feed, helping to support the increased growth and weight of young livestock. This is particularly important within China's growing pork industry; the growth demand for meat protein has resulted in increased demand for cheap animal feed sources. Current Chinese State Council policy forbids the use of UCO – sourced from catering and meat processing facilities – as a supplement for animal feed. Though this policy does not include high-grade used vegetable oils, uncontaminated by meat products, these are also beginning to be included as a UCO source.

Their inclusion will result in a better quality UCO biodiesel feedstock – containing lower levels of contamination and FFAs – but its removal from the animal feed supply chain will need to be replaced.

Since 2015, there has been a sustained increase in the amount of UCO exported from China to the EU. This has coincided with increased imports of edible oils during the same time period. Both soyabean and rapeseed oil imports have shown increases. However these are small when compared to palm oil; between 2016 and 2018, palm imports to China grew by 1M tonnes, representing an increase of more than 20%.

There are complexities relating to Chinese edible oil imports – such as their recent trade dispute with the USA, prompting the need to find alternative sources of soyabeans. However, the available trade data clearly shows China's increased consumption of palm oil. Although correlation does not constitute causation, this increase should not be ignored; there are clear parallels between increased exports of Chinese UCO and their imports of palm oil, with the growth of both expected to continue throughout 2019.

Consequently, there are concerns over the carbon intensity of UCO sourced from China, Indonesia and Malaysia, due to the potential inclusion of non-wastes within the waste feedstock stream. If their utilisation in EU biofuel production is leading to an increased use of palm oil within animal feed, replacing high grade uncontaminated used oil, then the subsequent ILUC emissions of palm oil should be included in the UCO assessment – or at least be flagged as a potential high ILUC-risk fuel.

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Traceability issues

The final, and perhaps most controversial, issue relates to the traceability of the UCO sourced from China. To access the European market, the supplied UCO must meet EU sustainability standards.

UCO collection points (CPs) – which source the waste directly from the places of origin – are audited on the documentation of the supplied materials. Each point of origin must be certified; however, the audit process requires only signed self-declarations as proof. Additionally, only large waste producers – generating more than 120 tonnes/year – are required to provide samples within the CP auditing framework.

These are relatively soft anti-fraud mechanisms that require a certain level of trust, making them susceptible to exploitation. The motive for this strengthens further when considering the market price of UCO. Figure 2 (*p22*) demonstrates the prices of UCO and crude palm oil are closely related – likely a result of their suitability as cheap biodiesel feedstocks.

As evidenced, during the last six months of 2018, the value of UCO was greater than CPO, resulting in increased exports of the commodity from China to the EU. This has continued into 2019, with Chinese UCO accounting for US$55.8M worth of imports in the first quarter alone. The higher value of UCO, and a lack of stringent traceability controls on the collecting points and points of origin in China, could give rise to fraudulent activity.

This potential for fraudulent activities – relating directly to biodiesel production from UCO – has been demonstrated recently within the Netherlands. Significant volumes of biodiesel sold there in 2015 and 2016 were wrongly designated as sustainable, with double-counting credits claimed as a result. Not only do instances like this raise doubt over the sustainability of certain imported feedstocks, they also undermine confidence in the entire biofuel sector, which could have much greater repercussions.

Conclusions

Utilising wastes which, without the existence of a biofuel market, would end up in landfill is seen as a preferable pathway option ahead of fuel crops.

The EU's well-defined legislative framework for wastes has established UCO as a key biodiesel feedstock. This demand is currently being met by a growing reliance on Chinese UCO imports. However, the feedstock quality, traceability and robustness of the supply chain's sustainability may not be as comparable to EU-sourced UCO.

Unlike the EU, estimations of UCO capacity and availability within China, Indonesia and Malaysia are inherently difficult to validate. Indeed, without a proper understanding of the current volumes of waste oil generated, it is almost impossible to substantiate the GHG savings associated with the feedstock or if additional wastes are being produced as a result of the EU's policy support for biodiesel production from imported UCO.

This is further exacerbated by the inclusion of possible non-wastes within the UCO waste stream – the redirection of high-grade waste vegetable oils, safe for consumption within animal feed, to biofuel production may result in their replacement with cheaper virgin edible oils, such as palm. The available evidence indicates that China's palm oil imports are increasing, in line with the country's increased exports of UCO.

If these are indeed connected, then the ILUC implications of using imported UCO as a feedstock for biodiesel could be significant and must be investigated. Furthermore, if imported UCO is to continue as a double counting feedstock, then confidence in its supply chain should be paramount. The certification process of UCO – sourced from outside the EU – should be more robust, helping to ensure that the feedstock meets comparable levels of traceability and sustainability. ●

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