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Towards healthier palm oil

3- and 2-MCPDs and GEs pose a potential cancer risk and it is therefore important for edible oil producers to limit the content of these compounds in their products to the highest possible degree. Dr Pat Howes suggests how palm oil producers, in particular, can minimise the presence of chloride and partial glycerides, which lead to the formation of MCPDs and GEs

3- and 2-monochloropropane diols (MCPDs) and their esters, and glycidyl esters (GEs), are suspected class 2 carcinogens, meaning they are probably carcinogenic to humans.

Limits for their content in foods have been set. For example, the EU limits the contaminants at 2ppm and 1ppm, respectively. To put their risk into perspective, a well-known class 1 carcinogen, known to be carcinogenic to humans, is tobacco and tobacco smoke.

3-and 2-MCPDs are found in highest concentrations in processed oils – such as palm oil, coconut oil, corn oil, and sunflower oil – and to a lesser extent in canola/rapeseed oil, olive oil and soyabean oil, among others.

In order to mitigate the presence of MCPDs and GEs in fully refined oils, producers need to understand how they are formed and then either mitigate the factors causing their production or absorb or otherwise remove the dangerous substances from the processed oil.

Palm oil makes up the largest volume of the oils mentioned above, so it will serve here as an example. GEs are formed from partial glycerides at high temperatures. For MCPDs to be formed, both partial glycerides and chloride/chlorine need to be present.

Oil palm loves equatorial climates, particularly coastal conditions. Therefore it has a potential to absorb chloride from the environment. The use of chloride-containing fertiliser is another possible source of chloride.

The chloride concentrates in the fruit bunches. After the oil palm fruit bunches are picked, the oil in the fruit undergoes degradation by enzymes, leading to the formation of partial glycerides and free fatty acids (FFAs). To minimise the partial glyceride formation, the fruit should therefore be sterilised as soon as possible after the fruit bunches are harvested.

Since oil palm grows in the equatorial belt, it is possible that the plantation sees rain for 200 days each year. Rapid

transport of the fruit bunches to the oil mill is not always possible, especially in plantations where the roads become muddy and impassable during rains (see photo, right).

Therefore, the standard of plantation roads is an important factor affecting the time from harvesting to sterilisation of the fruit, and thus on the partial glyceride content of the resulting crude palm oil (CPO).

Technology is available to stabilise muddy soil with a high clay content to produce cost-effective soil-cement-polymer roads, utilising in-situ materials. Through these methods, the roads can be usable all year round and the crops brought rapidly to the palm oil mills for processing.

Sterilisation

The sterilisation of the fruit bunches at the palm oil mill kills the enzymes causing degradation, essentially stopping the decomposition process that leads to partial glyceride production. Although partial glycerides and FFAs are formed together during the decomposition of oil, the FFA content of a crude palm oil may not be a good indicator of partial glyceride content, as the CPO may have been partially neutralised to lower its FFA. The partial glycerides would remain in the CPO after partial neutralisation.

When palm fruit bunches are processed at conventional mills, the fruit bunches are first sterilised with steam. The fruit can then easily be removed from the fruit bunches, and sent for oil extraction.

The sterilisation processes also leach chloride from the fruit bunches, which is concentrated in the steriliser condensate. The steriliser condensate contains some oil, and this oil is later recovered and recycled after decanting.

The operation of the decanter could be set to ensure that minimal chloride containing water is present in the decanted oil.

However, since oil is more valuable than water, the decanter is usually set to recover all the oil. With the oil comes some of the chloride-rich steriliser condensate. It is this condensate that is a major source of the chloride that forms the MCPDs.

The washing of the oil recovered from the steriliser condensate should be more cost-effective than washing the entire CPO batch. Any washing is best done at the palm oil mill, where the liquid effluent can be easily treated. It should also be noted that the chloride/chlorine content of steam and wash water must be minimised at all stages of the extraction and processing of the oil.

FRESH OIL PALM FRUIT BUNCHES MUST BE TAKEN TO OIL MILLS QUICKLY TO BE STERILISED BUT MUDDY ROADS CAN MAKE RAPID TRANSPORTATION DIFFICULT

CPO is predominately processed utilising physical refining. Washing the CPO at a physical refinery would be against the design philosophy of physical refining, namely keeping both capital costs and amounts of effluent low. Proper management of the steriliser condensate is therefore required for cost-effective management of chloride content in the CPO before it is sent to the refinery for further processing.

Some palm oil mills in countries such as Thailand and Colombia make use of a new technology for processing the oil palm fruit bunches. The technology involves removing the fruit from the fruit bunches – leaving the chloride in the empty bunches – and then only sterilising the fruits.

This technology enables the production of CPO with reduced chloride content, as required in MCPDs mitigation. Energy is also saved, as the empty fruit bunches are not sterilised, and the sterilisation capacity for palm fruit is increased, as no space is taken up by the empty fruit bunches.

Avoiding MCPDs...

It is then necessary to examine all the major processing stages at the refinery. 3-and 2-MCPD formation is reported to increase at higher temperatures and in the presence of strong acids. To minimise MCPD production at the degumming stage, it is better to use citric acid or ethylene diamine tetraacetic acid (EDTA), known as soft degumming, rather than phosphoric acid degumming agent. The use of lower temperatures utilised for chelative degumming should also prove beneficial. Similarly, at the bleaching stage, lower temperatures and the use of non-acidic bleaching earths have been reported to result in lower MCPD levels in bleached oils.

Activated carbon has long been utilised as an absorbent for chlorine compounds and for the removal of impurities from edible oils. It is therefore not surprising that activated carbons, when blended with bleaching earths, remove the chloride/chlorine, providing another means of reducing MCPD content in bleached oils.

...and GEs

Reports indicate that MCPD production at the deodorisation/steam refining stage does not seem to be significant. However, the deodorisation/steam refining stage is where GEs are produced, most significantly when the deodorisation temperature is above 240°C.

Process plant contractors are marketing systems to minimise the production of GEs through methods such as flash heating the bleached oil and then deodorising for longer periods at lower temperatures, for example at 240°C for two hours instead of at 260°C for 45 minutes.

These modified processes require additional space and significant capital investment, which are again contrary to the philosophy of physical refining.

Another approach is to utilise existing equipment and subsequently treating the produced GEs through methods such as absorption, or to break open the ring formed by two carbon and one oxygen atom in the molecular structure of the GEs that are produced during the conventional deodorisation process. Once the ring has been split, the molecule is no longer a GE.

These kinds of absorbents and catalytic materials have been identified and are in the process of being commercialised. In order to utilise the absorbents and catalysts, there will be some space and capital requirements for the necessary equipment. However, these requirements should be much less expensive than the solely engineering-based options.

It is also important to note that in GE control, the 'neutral oil' from the fatty acid stream should not be recycled during the deodorization stage as it is rich in the partial glycerides that leads to GE production.

This article was written by Dr Pat Howes, technical director at Malaysia's Natural Bleach Sdn Bhd