Unit II - Topic 8
Emulsifiers, preservatives

Three considerations when choosing emulsifiers

High-load emulsions are used to emulsify flavors, colors and clouds and mainly are found in soft drinks and other carbonated beverages as well as juice applications.

Emulsion innovation extends beverage stability

Constraints on beverage emulsion technology have centered on oil loading capacity, increased viscosity profiles and overall emulsion stability, according to TIC Gums, White Marsh, Md. In response the company is offering TICAmulsion products that provide high oil loading capacity emulsion concentrates with minimal viscosity build, which creates emulsions with excellent stability, according to TIC Gums.

TICAmulsion involves an OSA (octenyl succinic anhydride) modified acacia gum, said Jigar Rathod, a food scientist for TIC Gums. It is non-bioengineered. TIC Gums in December added to the line by launching TICAmulsion 3020, which uses patented technology to improve upon the natural emulsifying capabilities of acacia gum, according to TIC Gums.

High-load emulsions are used to emulsify flavors, colors and clouds and mainly are found in soft drinks and other carbonated beverages as well as juice applications, Mr. Rathod said. A smaller oil droplet is important.

“Physical separation of oil and water phases is a concern for all emulsions,” Mr. Rathod said. “The creaming rate or the rate at which these two phases separates depends heavily on oil droplet radius. The smaller the droplet size, the longer the shelf life of the emulsion.”

The high oil load capacity expands product development opportunities by enabling increased efficiencies and opportunities within beverage fortification, according to TIC Gums. An emulsifier concentrate manufacturer might be able to double the initial concentration of a nutritional oil or add multiple nutritional oils to the same emulsion concentrate.

Preservatives:

Chemical reaction

Microbial growth in soft drinks can produce off flavours and odours, clouding and 'inflation' of flexible packaging from carbon dioxide released by fermentation. In the worst case, customer health could be affected.

Preservatives can inhibit the growth of yeasts, moulds and many types of bacteria when used in conjunction with other hurdles to microbial growth, such as heat treatment, added acid (low pH), reduced water activity (sugar addition) and oxygen removal (eg via carbonation or nitrogen flushing). The quality and processing of raw materials should minimise the number of microbes introduced into soft drinks and, if any microorganisms are expected to survive into the final packaging, preservatives are added to prevent this small number from proliferating; rather than act as a sterilant for poor quality ingredients.

Preservatives are required in drinks that have either not been aseptically processed/packed, or require storage in a refrigerator after opening (dilutable squashes and cordials in the latter case). There are some microorganisms that can break down preservatives, and this can be combatted by preservative combinations and optimised plant hygiene, in conjunction with the multiple hurdle approach to preservation. Other chemicals and processes with a stabilising and sanitising action may be used in the treatment of mains water and the preparation of raw materials for soft drinks. Apart from certain defined exceptions, preservatives are not generally permitted in the EU in mineral water, fruit juices and dairy-based drinks.

Preservative science

The three primary preservatives in flavoured soft drinks in Europe are sorbic and benzoic acids (and their related salts) and dimethyl di-carbonate (DMDC), with sulphur dioxide (SO_2) playing a secondary role as a carryover preservative from other ingredients.

Sorbic and benzoic acids are weak acids that work best at low pH when their active, uncharged forms predominate.

A pH of below 4.6 also prevents the growth of clostridia (botulism) and contributes to the flavour of fruit flavoured drinks. A typical soft drink pH is 2.7 to 3.7. Above pH 4.6, ambient-stable drinks should be UHT treated and aseptically packed.

Sorbic and benzoic acids have poor solubility, and therefore they are generally used in the form of more soluble potassium and sodium salts respectively. Pre-dissolved acidulant (and fruit juice) is added near the end of the process in order to partially convert the dissolved preservative salt into its less soluble free acid form. This mixing is carried out slowly in as dilute a solution as practicable in order to minimise the chances of free acid coming out of the solution.

Potassium sorbate is about 75 per cent sorbic acid and sodium benzoate is about 84 per cent benzoic acid. Potassium sorbate and sodium benzoate cannot be dissolved directly in acid or fruit juice. The presence of undissolved preservative can be the basis of consumer complaint and also causes problems during carbonation.

Sorbate and benzoate work well together, in particular in very low pH drinks where preservative solubility can become more of an issue as the level of free acid increases. A lower maximum sorbic acid level is specified when it is used together with benzoic acid. A lower sorbic acid level can be an advantage in mildly flavoured drinks. Benzoic acid has better solubility than sorbic acid in high solids cordials and squashes. Some preservative breakdown can occur during processing – increased by, for example, oxygen and iron at higher temperatures.

The use of sodium benzoate in soft drinks is often avoided in the presence of vitamin C, which can potentially convert the benzoate salt into benzene. DMDC is very effective and is metred into the product immediately prior to filling using specialist equipment. Since DMDC breaks down rapidly after addition, it is not practical to add earlier in the process or indeed check its level after packing. DMDC presents certain challenges as far as maintaining a safe production environment is concerned. DMDC is sometimes used with potassium sorbate.

Natural occurrence

Benzoic acid occurs naturally (with vitamin C) in many types of berry fruits – sometimes at higher levels than permitted in soft drinks under EU additives legislation. Sorbic acid was also first identified as a naturally occurring compound in plants. There are also other naturally occurring materials claimed to have preservative effects, such as saponins and flavonoids.

SO2 is an allergen and is only permitted at low levels as carryover from raw materials such as fruit concentrates and purées (where higher SO2 levels are permitted as a preservative/ colour stabiliser). SO2 does not have to be declared if it is present at up to 10ppm in the final drink. Higher levels must be declared on the label up to a maximum permitted level of 20ppm.

After packing off, some of the SO2 will diffuse out of the drink into the headspace, where it can still fulfil a useful function of preventing mould growth on the surface of the drink, in particular in non-carbonated drinks.

Preservative enhancers

The choice of acidulant is influenced by the required flavour profile. Citric and malic acids are popular; the latter is often used for flavour reasons in drinks containing artificial sweeteners. Phosphoric acid is compatible with cola flavours; the maximum permitted use levels of phosphoric acid (and phosphates) are based on the P2O5 content and the application (a lower maximum level is specified for sports drinks).

Acidulants are sometimes used with corresponding acid salts to form a buffer system in order to achieve a better control of pH and a more intense flavour note. An example would be citric acid with tri-sodium citrate.

Other additives can have a preservative-like effect in that they can increase shelf life. Vitamin C as an antioxidant can maintain colour for longer and preserve other vitamins, eg vitamin E. Sequestrants such as sodium citrate and sodium phosphates can bind traces of heavy metals like iron, to inhibit oxidation and also enhance the effectiveness of preservatives.

Carbonation (typically 1.5 to 5 g/l) not only produces a more refreshing drink, but also lowers pH, moderates sweetness and the carbon dioxide has a preservative effect, since yeast fermentation is inhibited by carbon dioxide and the lack of oxygen inhibits mould growth. A lack of oxygen also inhibits undesirable oxidation reactions, which can produce off flavours and colours.

Processing and packaging

A combination of raw material quality controls (including water treatment) and heating (eg flash pasteurisation of fruit syrups) in conjunction with strict GMP and plant cleanliness contributes to a low initial bio burden in raw materials. Filtration and/or reverse osmosis membrane technology can remove cryptosporidium, bacteria, viruses, pesticides and organic off flavours in mains water.

Water softening can reduce the formation of haze in clear drinks, reduce alkalinity and remove destabilising metals salts such as iron, which also encourage microbial growth and the formation of off flavours. Plastic packaging is permeable to oxygen, which can limit the shelf life of some carbonated drinks, compared to equivalent canned drinks. Transparent plastic packaging can result in the degradation of ingredients such as vitamin C over shelf life. This is exacerbated in the presence of oxygen, and therefore carbonation or nitrogen flushing can extend shelf life of vitamin C in clear bottles.

Chlorine, ozone, hydrogen peroxide, peracetic acid and UV light have been used in initial sanitising steps for process water or in preparing sterile packing. Chlorination works best at pH 3 to 5. Chlorine residues must be removed by filtration to optimise flavour and protect fragile downstream filtration membranes. Aseptic processing and packaging or the use of in-pack pasteurisation (including high pressure treatment) can remove the need for preservatives and allow a higher pH for more neutral taste profiles, for example in cold tea drinks.