

ERYLITE® Erythritol in beverages

Introduction

ERYLITE® Erythritol is a naturally occurring sugar alcohol that is manufactured from glucose by an entirely natural fermentation process. Sugar alcohols, also known as polyols, comprise substances that are commonly used as food additives, such as sorbitol, maltitol and xylitol.

Erythritol has only been introduced relatively recently as a food additive. The exceptional combination of features is just beginning to find its way into the development of novel food and beverage products. Erythritol provides a unique alternative to other polyols, and other bulk sweeteners, used in numerous products today. These unique attributes, which make it a product category in its own include very low calorie content, high digestive tolerance and low hygroscopicity. Erythritol is a naturally occurring substance that is found in many food articles such as wine, soy sauce and a variety of fruits (1), which distinguishes it from other polyols. It is an approved food additive in Japan since 1990 and the US FDA granted the GRAS status (generally recognized as safe) in 1996. It is also approved in numerous countries worldwide such as Australia, New Zealand, Canada, Taiwan, Korea, Israel, South Africa and Mexico. In the EU, erythritol is currently in the final stage of its regulatory approval. In the USA and Canada, it is approved for use in beverages to a level of 3.5 % (w/w). The initial approval in the EU will not include the use in beverages.

Beverages

Beverages constitute a basic part of the human daily diet contributing energy, hydration and essential elements for human nutrition. These highly convenient products enjoy a worldwide sustained and continuous market growth driven by their popularity and product range. The fastest growing share of the market today is the new age, energy and sport drinks, special beverage products that are tailored to the changing needs of consumers. New beverages launched in Japan, Europe, and North America have catered extensively for the very wide variation of trends and lifestyles in these regions. With very high growth rates and very innovative approaches being offered, this category requires constant renewal of products and thus relies heavily on innovative ingredients. Low calorie and sugar free options continue to present a major opportunity for development in the beverage industry in this respect.

The foremost task of a beverage is to quench thirst and provide refreshment. A functional sport or recovery beverage should furthermore provide hydration and replenish essential nutrients lost during physical exertion or exercise.

This can only be successfully achieved if the beverage also offers a pleasant taste, otherwise it will never be consumed twice. In a classical basic soft drink this is realised by a refreshing tartness accompanied by sweetness. For sugar free and low calorie beverages the key challenge is to find a sweetening system equivalent to sugar. For replacement of sugar mainly three options are possible:

- 1) Intense sweeteners (non nutritive)
- 2) Reduced calorie bulk sweeteners (polyols)
- 3) Combinations of various intense and low calorie bulk sweeteners.

Low Calorie / Sugar Free beverages

The large number of sweetening agents available inhibits the replacement of sugar by developers: Each potential solution is often a compromise between calorie content and taste quality. Today's standard sweetener solutions for low calorie beverages are the intense sweeteners. They provide sufficient sweetness and are widely accepted by the consumers worldwide. Products such as aspartame, sucralose or saccharin have a sweetening power that is between 60 to 600 times higher than sugar. Unfortunately, these products lack the ability to provide body and mouthfeel to a product. The reason is that they are used at minute quantities, so they do not contribute to the density and thickness of the drink. Another major disadvantage of the intense sweeteners is that their taste profile is hampered by bitter and lingering sweet aftertaste.

Polyol bulk sweeteners can be an alternative. They are lower in energy content than sugar and are able to provide sweetness. Polyol are bulk ingredients which are typically used in larger concentrations that provide substantial mouth-feel to the beverage. Whereas most polyols are limited in use due to their potential laxative effect at higher doses, ERYLITE® is much better tolerated and can be used up to a 3.5% (e.g. in USA, Canada). Since polyols are usually less sweet than sugar a combination of polyol and intense sweeteners is recommended: sweetness and mouthfeel are provided while the caloric content of the drink is kept very low. So far, polyol and intense sweetener combinations have not been introduced in the market for three reasons:

- 1) the potential laxative effect of higher polyol contents in beverages was considered a serious health risk and too difficult to communicate to consumers
- 2) the existing polyols do not substantially contribute to sweet taste quality and current polyol/intense sweetener combinations are not free from the undesirable aftertaste
- 3) most polyols have in general not been approved for use in beverages

The taste imparted by non nutritive sweeteners in drinks is also referred to as "diet taste", meaning a slow onset but lingering of sweetness accompanied by a bitter / metallic undesirable aftertaste. A growing percentage of consumers are disappointed with the taste profile of a drink that is considered healthy or functional and they are not willing to sacrifice the taste for the sake of a nutritional benefit. The insufficient taste is therefore a major hurdle that needs to be overcome to satisfy the consumer and provide a successful low calorie or sugar free drink.

Why is ERYLITE® different from other Polyols?

Taste Improving

ERYLITE® has a taste profile similar to sucrose. The dominant taste perception is clearly the clean sweetness, but it also conveys smoothness, and more important, slightly more body than sucrose. Although the sweetening power is approximately 50% of sucrose, the final sweetness contribution from ERYLITE® depends on the application it is used in and the presence of other sweetening substances.

The sweetening capacity of ERYLITE® is best utilized in combination with an intense sweetener. Then a (qualitative and quantitative) synergy on the sweetness can be observed. ERYLITE® also masks the intense sweeteners aftertaste and is also capable of lowering the astringency of a sweetener such as sucralose.

Non-caloric

ERYLITE® has a uniquely low caloric value of 0.2 kcal / g. This is the lowest caloric value of all polyols and other bulk sweeteners. The reason is that ERYLITE® is absorbed for > 90 % in the small intestine and excreted again via the kidneys / urine. The remaining < 10% are fermented in the colon and are finally made available to be metabolized with a maximum caloric value of 0.2 kcal / g.

Caloric Values of Polyols and sucrose

Polyol	Calorie Value (kcal/g)
ERYLITE® Erythritol	EU: 0.0 USA: 0.2
Polydextrose	1.0
Isomalt	2.4
Maltitol	2.4
Mannitol	2.4
Sorbitol	2.4
Xylitol	2.4
Sucrose	4.0

Low GI

Food ingredients and additives with a low glycaemic index are of growing interest since more and more foods are being developed aiming to reduce the glycaemic response. Although this is particularly useful for Type II diabetics, it is becoming more accepted that a reduced glycaemic load provides overall a health benefit. The consumption of ERYLITE® does not raise the plasma glucose or insulin levels at all which makes it a suitable sweetener for diabetics.

Digestive Tolerance

Excessive consumption of most polyols is known to provoke undesirable effects in the intestine, diarrhoea in the worst case. These problems reside in the lower digestive tract (large intestine) where metabolic malfunction is initiated either by osmotic disequilibrium or by fermentative degradation products. Since more than 90% of the ERYLITE® dose is readily absorbed in the small intestine, only small amounts reach the large intestine. This special metabolic behaviour of ERYLITE® increases the digestive tolerance to an acceptable threshold which is twice as high as for other polyols. This feature is of extraordinary importance for beverages where the polyol intake can be considerable.

Digestive tolerance (laxation) threshold for ERYLITE® and other polyols (g/kg body weight, consumed in foods) (2):

Polyol	Laxation Threshold
ERYLITE® Erythritol	> 0.66
Polydextrose	0.46
Maltitol	0.42
Isomalt	0.32
Sorbitol	< 0.30
Lactitol	0.25

Non cariogenicity

ERYLITE® is not converted to organic acid by the oral bacteria. Organic acid metabolised from sugar accounts for low dental pH which is affecting the calcium based tooth enamel and thus represents a major cause for tooth decay. The consumption of ERYLITE® does not lower the oral pH. This has been shown repeatedly in official non-cariogenicity tests (Mühlmann test) ERYLITE® also offers other useful properties:

- Excellent heat and acid stability which protects it from degradation during heating processes and through prolonged storage
- ERYLITE® is not hygroscopic which makes it an easy to use ingredient wherever dosage is crucial
- Negative heat of solution, leading to a cooling effect in the mouth upon dissolution ERYLITE® does not undergo Maillard reaction (development of colour and taste)

How could beverages benefit from addition of ERYLITE® ?

Common “light” products

Practically all of the currently available “diet” or “light” versions of regular soft drinks can be improved significantly in terms of taste and other attributes with ERYLITE®. The benefit of ERYLITE® is that it can be used alone, however, in low calorie soft drinks, it achieves the best quality improvements when used in combination with intense sweeteners.

ERYLITE® provides practically no calories while maintaining the body and mouth-feel of a full calorie drink. A complete replacement of sugar with the maximum dose of 3.5 % ERYLITE® in a drink, leads to a calorie contribution of only 7 kcal / litre or 1.7 kcal / serving (8 fl.oz.), which is only 5% of the full-sugar equivalent (140 kcal / litre, 33.18 kcal / serving).

Also the overall taste quality is rounded compared to the use of intense sweeteners only and the bitter or metallic aftertaste is reduced.

Apart from this qualitative improvement, ERYLITE® also brings a quantitative synergy in the level of perceived sweetness. When ERYLITE® is used as the major sweetening component with addition of either aspartame or acesulfame K in a ratio of 85:15, the perceived sweetness is increased by 30% and 32%, respectively (3). This means that the dosage of these sweeteners can be reduced by an equal percentage offering a significant saving on intense sweetener costs.

The consequence of using lower intense sweetener dosage reduces the absolute amount of degradation during production and storage and the resulting loss in sweetness. It obviously also reduces the perception of the after-taste from the intense sweetener. ERYLITE® is perfectly stable in a pH range of 2 – 10 even at high temperatures, and thus easily resists heating processes such as pasteurization or sterilization. Hence, ERYLITE® does not impact negatively on the shelf life of the finished product, but helps to reduce the loss of sweetness from intense sweeteners and consequently improves the physical and flavour stability of low calorie drinks. ERYLITE® exhibits these effects independently of the use of flavours or other taste enhancers. ERYLITE® does not react or interfere with other additional ingredients used.

Functional Drinks / Near Water Drinks

The functional drink group contains a number of different beverages that are targeted to specific consumption occasions. Sport Drinks, Energy Drinks, Wellness Drinks and Nutraceutical drinks are common subgroups. The importance of each group varies widely in different areas of the world. Within the wellness drink segment near water drinks are of great importance for all beverage markets worldwide.

This category has shown a tremendous potential in Japan and is now gradually expanding to other Western markets. These drinks are usually perceived as healthy and supportive to wholesome nutrition. The demand for these beverages continues to increase as consumers require great taste with low caloric content. Near water drinks are primarily based on mineral water (still and carbonated) that contains other low-level ingredients, which makes the final drink appear as water. Finally, near water is an optical classification.

Typically, near water drinks have a fruity aroma and are enriched with vitamins and minerals to provide a tasty drink with healthy added value. These types of beverages are often sweetened to enhance their flavour. ERYLITE®, as a low calorie bulk sweetener, is an excellent ingredient to contribute to the healthy image of near water drinks. Replacing the intense sweetener with a more natural ingredient is a major step in improving the product image while maintaining the body of the drink and providing support for the flavour to unfold. Similarly Japanese Near Water drinks that are often enriched with minerals, even caffeine or royal jelly may be added.

In Japan drinking habits include substantial purchases of hot and cold beverages from street vending machines. Especially hot beverages could benefit from ERYLITE®. Since the intense

sweeteners are sensitive to temperature, ERYLITE® can be used as a heat stable ingredient. For many other functional drinks where replacement of sugar or the need for a stable sweetening solution is a major issue, ERYLITE® can satisfy both requirements.

Frozen carbonated drinks (slush type drinks)

Frozen carbonated drinks are popular in North America and Canada and are of increasing interest in Europe and Japan. They are typically non-alcoholic and consumed independently from seasons. They are sold directly from dispensers (granitors) in 'cocktail' bars and fast food shops. Frozen carbonated soft drinks are available in a number of flavours, mostly fruit and 'cocktail' flavours (e.g. Pineapple, Pina Colada, Bloody Mary, etc)

From a technology point of view, frozen drinks are a sophisticated food system. The clue is to make a semi solid drink at a temperature where water is already frozen. This can be achieved by modulating the freezing point depression of the mixture, usually by admixing a substance that decreases the freezing point of water (1 mol of substance decreases the FP by 1.86 °C). The choice of substance is obviously important to achieve this in a stable and economical way.

Typically sugar is used to lower the freezing point: A slush type drink contains approx. 10% of sugar which equals 0.3 mol of sugar and thus provides a useful but limited FP depression. ERYLITE® meets this requirement easily. Since the molar mass of ERYLITE® is 122 g (36% as compared to 342 g for sugar) it exhibits a more pronounced freezing point depression for the same weight of sugar. Based on 0.3 mol of solute required for the freezing point depression, 36 g of ERYLITE® is enough to achieve the same effect as 100 g of sugar. In other words a 3.5% ERYLITE® dose in a slush drink will provide the same freezing point depression as a 10% sugar based drink (4).

Since ERYLITE® has only 50% the sweetness of sugar, an intense sweetener needs to be added to supplement the sweetness level. The effect of the intense sweetener on the freezing point depression is negligible: the concentration of the intense sweetener is low and the molar mass is, in most cases, significantly higher. Moreover, this sweetener combination would provide a similar taste and mouthfeel as a full sugar drink.

Considering energy content 10% sugar in a drink contributes a caloric content of 400 kcal / l. Replacing sugar with ERYLITE® to the required amount of 3.5%, reduces the caloric content by 98%. The drink is practically free of calories and merits the title of healthy refreshment for everybody, even diabetics.

Conclusion:

ERYLITE® Erythritol is a safe, naturally occurring food additive. Its unique combination of features qualifies it for application in beverages where it can serve numerous functions. It is a low calorie bulk sweetener with an excellent digestive tolerance. It has a taste profile close to sugar and can easily replace sugar in low calorie recipes, preferably in combination with intense sweeteners. Its sweetness synergy with intense sweeteners improves taste profile and reduces costs, while reducing stability problems in processing and storage. It is also non-cariogenic and suitable for diabetics.

For further product information and samples of Jungbunzlauer ERYLITE®, please contact your local Jungbunzlauer sales organisation or contact us by visiting our web site at www.jungbunzlauer.com.

References:

- (1) Erythritol: A review of biological and toxicological Studies, W.O. Bernt, J.F. Borzelleca, G. Flamm, I.C. Munro, Regulatory Toxicology and Pharmacology 24 (1996), S191 – S197.
- (2) Tolerance of low-digestible carbohydrates: a general view, Geoffrey Livesay, British Journal of Nutrition (2001), 85, Suppl. 1, S7 – S16
- (3) (3) Erythritol: A Novel Noncaloric Sweetener Ingredient, P. de Cock, World Rev Nutr Diet. Basel, Karger 1999, vol85, pp110 – 116
- (4) (4) United States Patent 202/0009530, DuBois et al.

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