

Supporting document 1

Risk and Technical Assessment Report – Application A1103

Citric & Lactic Acids as Food Additives in Beer and related products

Executive Summary

FSANZ received an Application from DB Breweries Limited seeking to amend Standard 1.3.1 – Food Additives of the *Australia New Zealand Food Standards Code* (the Code) to permit the addition of citric and lactic acids as food additives in beer. Within Standard 1.3.1, this permission would apply to the food category 14.2.1 - Beer and related products.

Citric and lactic acids are currently permitted as food additives in a large range of foods at levels consistent with Good Manufacturing Practice (GMP). For the proposed use of citric and lactic acids in beer and related products, this Application also requests GMP permission.

The food technology assessment concluded that certain types of beers exhibit improved flavour profiles due to pH reduction achieved by the addition of citric and lactic acids. Maximum levels of addition are expected to be approximately 3 g per litre of beer (total of citric acid plus lactic acid).

Citric acid and lactic acid are substances of very low toxicity. Citric acid occurs in many foods, with levels of approximately 10 and 50 g/L in orange juice and lemon juice, respectively. Lactic acid levels are highest in foods produced by fermentation, with levels of approximately 10 g/kg reported for cheese and yogurt. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) concluded that establishment of an Acceptable Daily Intake (ADI) expressed in numerical terms was unnecessary for either substance.

It is concluded that the use of citric and lactic acids as food additives in beer and related products is technologically justified and presents no public health and safety issues.

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1 Introduction

On 10 September 2014, Food Standards Australia New Zealand (FSANZ) received an Application from DB Breweries Limited seeking to amend Standard 1.3.1 – Food Additives in the *Australia New Zealand Food Standards Code* (the Code), to permit the use of citric and lactic acid as food additives in beer. Within Standard 1.3.1 this permission would apply to the food category 14.2.1 - Beer and related products.

Citric acid and lactic acid are listed in Schedules 1 and 2 of Standard 1.3.1. Citric and lactic acids are permitted for use in accordance with Good Manufacturing Practice (GMP) in a wide range of foods including breads and bakery products, processed cereal products, flour products (including noodles and pasta), processed meat, fruit and vegetable juices, infant formula products, water based flavoured drinks, and wine.

1.1 Risk assessment context

For the purpose of this risk assessment, the proposed addition of citric and lactic acids to beer and related products in Australia and New Zealand will be considered in the context of the following:

- Citric and lactic acids are proposed for use in beer and related products as acidity regulators;
- The proposed usage is in accordance with GMP.
- As this risk and technical assessment is applicable to both beer and related products, the term 'beer' is used to capture this food category throughout this supporting document.

1.2 Risk and Technical Assessment questions

For this Application, the risk assessment questions were developed in the context of the section 18 Objectives of the *Food Standards Australia New Zealand Act 1991*.

The following risk assessment questions are addressed in this report:

1. Do citric acid and lactic acid achieve their stated technological function in the form and quantity used as food additives in beer?
2. Are there any public health and safety issues associated with the use of citric and lactic acids as food additives in beer?

2 Food technology assessment

2.1 Characterisation of citric and lactic acids

2.1.1 Identity, chemical and physical properties

Information on the identity, chemical and physical properties of citric and lactic acids are summarised in Table 1.

Table 1: Identity, chemical and physical properties of citric and lactic acids

Property	Citric acid	Lactic acid
Common name	Citric acid	Lactic acid
Other names	2-hydroxy-1,2,3-propanetricarboxylic acid	2-hydroxypropanoic acid 2-hydroxypropionic acid
Structural formula		
Chemical Abstract Service (CAS) registry number	77-92-9 (anhydrous) 5949-29-1 (monohydrate)	50-21-5 79-33-4 (L- form) 10326-41-7 (D- form) 598-82-3 (DL- form)
Chemical formula	C ₆ H ₈ O ₇ (anhydrous) C ₆ H ₈ O ₇ ·H ₂ O (monohydrate)	C ₃ H ₆ O ₃
Molecular weight g/mol	192.13 (anhydrous) 210.14 (monohydrate)	90.08
Food additive number (INS)	330	270
Physical state at room temperature	White or colourless, odourless, crystalline solid; the monohydrate effloresces (loses water, the monohydrate molecule) in dry air	Colourless, syrupy liquid or white to light yellow solid or powder
Melting point (°C)	152-159	16.8
Boiling point (°C)	None, decomposition >175	258 (at 1000 hPa – close to atmospheric pressure)
Water solubility (g/L)	576-771	876
Octanol-water partition coefficient (log K _{ow})	-1.72	-0.62
Dissociation constant (pKa)	pKa ₁ 3.13; pKa ₂ 4.76; pKa ₃ 6.4	3.68

2.1.2 Production of citric and lactic acids

Citric acid is typically produced from fermentation processes with subsequent extraction and purification steps. The fermentation of sugar (the Application mentions molasses as the sugar source) is usually performed by moulds from the *Aspergillus niger* family.

Lactic acid is produced via a similar production process. That is, it is obtained from a fermentation of sugar using lactic acid bacteria. Subsequent extraction and purification steps are involved.

2.1.3 Specifications

Permitted food additives are required to have a specification in the various monographs of the references in clause 2 or 3 of Standard 1.3.4 (Identity and Purity).

Citric acid and lactic acid each have a Joint FAO/WHO Expert Committee on Food Additives (JECFA) specification in the Combined Compendium of Food Additive Specifications¹ which is the specification reference 2(b) of Standard 1.3.4. The JECFA specification for citric acid includes the anhydrous and monohydrate forms, while for lactic acid the L-, D- and DL- forms are specified.

2.1.4 Methods of analysis in foods

Citric and lactic acids have been permitted as food additives for a wide range of foods for many years so there is no requirement to develop new analytical methods for enforcement purposes.

Since citric and lactic acids are both by-products of beer fermentation and so naturally present in the final beer, any analysis of beer will quantify both the natural levels of the acids and the amounts added as food additives. Analytical methods will not be able to differentiate the amount of the acids added compared to the levels naturally occurring.

There are a number of reverse phase High Performance Liquid Chromatography (HPLC) analytical methods available to measure both citric and lactic acids in beer, as well as in other alcoholic and non-alcoholic beverages which could be adapted.

2.2 Technological functions

The main technological function of both citric and lactic acid as food additives is as acidity regulators. Both are food acids and so their addition to food makes it more acidic.

The Codex Standard CAC/GL 36-1989 (Class names and the international numbering system for food additives) lists the function class and technological purpose of lactic acid as acidity regulator. Citric acid also has the additional function classes and technological purposes of antioxidant, colour retention agent and sequestrant. The Applicant is seeking the permission for the two food additives to be added during beer production to perform the technological function as acidity regulators.

Standard beer fermentation causes the pH of the initial wort (the name used for the aqueous extract of malt, before the yeast fermentation commences) to decrease to that in the final commercial beer. Part of the reason for the pH drop is due to the yeast producing a range of organic acids (the major ones being citric and lactic acids) as by-products of the yeast fermentation that converts wort to beer. Beer typically has a pH in the range 3.8-4.6. The pH has an impact on the flavour and mouth feel of beer.

There are some styles of beers which typically have higher pHs which benefit from additions of food acids to reduce the pH to the more typical beer pHs. These beer styles are lower alcoholic strength beers and flavoured beers.

¹ An online edition of the Combined Compendium of Food Additive Specifications is available at <http://www.fao.org/food/food-safety-quality/scientific-advice/jecfa/jecfa-additives/en/>

Some styles of lower alcoholic strength beers are produced using limited beer fermentation to reduce the concentration of alcohol formed. This reduced or limited fermentation also has the effect of limiting the pH reduction which would result in higher pHs of the final beers. Such higher pH, lower alcohol beers can have unsatisfactory sensory attributes. Shorter limited fermentations usually leave greater levels of unfermented sugars in the beer so they taste sweeter. Addition of tart organic acids helps to counterbalance the higher sweetness. Beer manufacturers therefore prefer to reduce the pH by the addition of common food acids which are already contained in the beer, being citric and lactic acids.

The other forms of beers that may require the addition of citric and lactic acids are flavoured beers. Fruit flavoured beers are very common and have a long history in various parts of the world. The most famous are the Lambic fruit beers of Belgium, such as the Kriek (cherry) and Framboise (raspberry) beers.

Typical pHs of standard beers can be too high for added flavours where the perceived flavour characters are not fully optimised. This may be due to the alteration in the balance of sugars and acids in the beer. It can also be because consumers associate acidity character with flavoured beers such as the well-known Lambic beers which are traditionally quite acidic. Citric acid is often added to complement the flavours of raspberry, strawberry, orange and lemon-lime by adding the sharp tart flavour associated with citric acid. Citric acid has a synergistic effect to optimise these fruit flavours by providing a short sharp acid note. By comparison lactic acid provides a smoother more dairy type flavour which can be used by itself or in combination with citric acid to complement the flavours of peach, apricot and cherry to provide a softer longer acidity. Flavoured beer manufacturers will do their own taste test profiling to determine the optimal pH profile that best suits their beers with the flavours used.

The Application stated that the addition of approximately 1500 mg/L of the two food acids, citric and lactic, individually or in combination, will lower the pH of beer by 0.5 units. However, in circumstances where the pH is exceptionally high an addition of up to 3000 mg/L may be necessary.

2.3 Conclusion

The analysis concludes that certain types of beers (i.e. some types of low-alcohol and flavoured beers) benefit by improving their flavour profile by the addition of the naturally occurring food acids, citric and lactic acid, as food additives with the technological function of acidity regulators. Both acids have JECFA specifications, which are one of the primary specification sources in Standard 1.3.4.

3 Hazard assessment

3.1 Citric acid

Citric acid is an intermediary substance in human metabolism, being engaged in the tricarboxylic acid cycle (Voet and Voet 2004). Citric acid also occurs in many foods (see Section 4). JECFA established a group Acceptable Daily Intake (ADI) "not limited" for citric acid and its calcium, potassium and sodium salts (WHO 1974). The term ADI "not limited" is no longer used by JECFA, however it has the same meaning as the current term ADI "not specified", which is applicable to a food substance of very low toxicity for which the total dietary intake of the substance arising from its use at the levels necessary to achieve the desired effect and from its acceptable background levels in food, does not, in the opinion of JECFA, represent a hazard to health. Establishment of an ADI for citric acid expressed in numerical form was therefore not deemed necessary by JECFA.

3.2 Lactic acid

Lactic acid is a normal intermediary of mammalian metabolism arising from glycogen breakdown, from amino acids and from dicarboxylic acids such as succinic acid. Lactic acid levels can be particular high in fermented foods (see Section 4). JECFA concluded that because lactic acid is a normal constituent of food and a normal intermediary human metabolite, it was considered unnecessary to set a numerical ADI. As for citric acid, an ADI “not limited” was established (WHO 1974b).

4 Dietary exposure assessment

Citric acid occurs in many foods, with the highest levels found in citrus fruits. Orange juice and lemon juice contain citric acid at levels of approximately 10 and 50 g/L, respectively, and levels in ready-to-consume fruit juice beverages determined in a US study ranged from 4.4 to 25 g/L (Penniston et al 2008). Lactic acid levels are highest in foods produced by fermentation. Levels of approximately 10 g/kg have been reported for cheese and yogurt (Park and Lee 2005; Shima et al 2012) and 1.5 g/L for wine (Sannino et al 2013). As indicated in Section 2.2, the maximum expected level of addition to beer is 3 g/L (total citric acid and lactic acid in combination).

A dietary exposure assessment was not conducted as the establishment of numerical ADIs was not deemed necessary by JECFA.

5 Risk characterisation

Citric and lactic acids occur naturally in a large range of foods, are products of human metabolism and are widely used as food additives. Assessments by JECFA concluded that both substances are of very low toxicity. Dietary exposure to citric and lactic acids resulting from use as food additives in beer presents no public health and safety issues.

6. Risk and technical assessment conclusions

This risk and technical assessment evaluated the technological suitability and safety of the proposed addition of citric and lactic acids to beer.

6.1 Responses to risk and technical assessment questions

1. *Do citric acid and lactic acid achieve their stated technological function in the form and quantity used as food additives in beer?*

Section of report	Summary response/conclusion
Section 2	Evidence submitted in support of this Application provides adequate assurance that citric and lactic acids fulfil the stated technological function as food additives in beer.

2. Are there any public health and safety issues associated with the use of citric and lactic acids as food additives in beer?

Section of report	Summary response/conclusion
Sections 3, 4 and 5	There are no public health and safety issues associated with the proposed use of citric and lactic acids as food additives in beer and related products.

6.2 Consolidated conclusion

It is concluded that the use of citric and lactic acids as food additives in beer and related products is technologically justified and presents no public health and safety issues.

7 References

Park YW, Lee JH, Lee SJ (2006) Effects of frozen and refrigerated storage on organic acid profiles of goat milk plain soft and Monterey Jack cheeses. *Journal of Dairy Science*, **89**(3):862–871.

Penniston KL, Nakada SY, Holmes RP, Assimos DG (2008) Quantitative assessment of citric acid in lemon juice, lime juice, and commercially-available fruit juice products. *Journal of Endourology*, **22**(3):567–570.

Sannino C, Francesca N, Corona O, Settanni L, Cruciata M, Moschetti G (2013) Effect of the natural winemaking process applied at industrial level on the microbiological and chemical characteristics of wine. *J Biosci Bioeng*. **116**(3):347–356.

Shima ARR, Salina HF, Masniza M, Atiqah AH (2012) Viability of lactic acid bacteria in home-made yogurt containing sago starch oligosaccharides. *International Journal of Basic & Applied Sciences*, **12**(1):58–62.

Voet D and Voet JG (2004) *Biochemistry* (3rd ed.), John Wiley & Sons.

WHO (1974a) Toxicological evaluation of some food additives including anticaking agents, antimicrobials, antioxidants, emulsifiers and thickening agents. WHO Food Additive Series, No. 5. Citric acid and its calcium, potassium and sodium salts.
<http://www.inchem.org/documents/jecfa/jecmono/v05je24.htm>

WHO (1974b) Toxicological evaluation of some food additives including anticaking agents, antimicrobials, antioxidants, emulsifiers and thickening agents. WHO Food Additive Series, No. 5. Lactic acid and its ammonium, calcium, potassium and sodium salts.
<http://www.inchem.org/documents/jecfa/jecmono/v05je86.htm>