Fruit juice nutrition and health
S. Landon

Fruit juice is a nutritious beverage that is currently included as an option within the fruit servings of the Australian Guide to Healthy Eating. Nutrient comparisons of commonly consumed fruit juices and whole fruit counterparts support the retention of fruit juice as a fruit serve option in the soon to be revised Australian Guide to Healthy Eating. Analysis of the National Nutrition Survey showed that fruit juice provided 33% of the vitamin C in children’s diets, a larger contribution than whole fruit and 25% of adult vitamin C intake. Fruit juice provided 2% of energy to 2–18 year olds and 1% of adult energy intake. Studies of fruit juice and bodyweight have mixed findings. Some recent studies indicate no link between 100% fruit juice and overweight in US children as well as Australian adolescents. The available evidence supports general intake advice of 1–2 moderate serves of fruit juice as part of a varied diet in conjunction with an active lifestyle.

Fruit juices have an important role to play as part of a healthy diet. One glass of fruit juice is an important source of fluids and can provide vitamin C, folate, potassium and antioxidants. As stated in the Australian Guide to Healthy Eating (DHFS 1998), fruit juice can count towards a serve of fruit a day. Some fruit juices available on the market are also fortified with calcium, folate, fibre and vitamin A, as permitted by Food Standards Australia New Zealand (FSANZ) (Standard 1.3.2, Food Standards Code) so that their nutritional contribution to the diet is further enhanced.

Internationally, the consumption of fruit and vegetables has been encouraged by many public health campaigns such as include the World Cancer Research Fund 5+ a day program and the Australian Government, State and Territory health initiative Go for 2 and 5. The World Cancer Research Fund promotes year-round consumption of a variety of vegetables and fruits, translating to five or more servings of fruit and vegetables daily (or 7% or more total energy), whereby fruit juice can count as one serve (WCRF 2004). This recommendation is based upon “epidemiological and experimental evidence that the recommended diets decrease the risk of certain cancers. Over time, the implementation of one recommendation – the consumption of 400 g/day or more of a variety of vegetables and fruits – could decrease the overall incidence of cancer by at least 20%” (WCRF 2004). Further support for the consumption of fruit and vegetables has also emerged in the area of vascular health. High fruit and vegetable intake lowered risk of stroke by 31% and fruit juice (citrus) lowered it 19% (Joshipura & others 1999).

Table 1. Fruit recommendations for adults, adolescents and children.

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Recommended servings of fruit/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>4–7</td>
<td>1</td>
</tr>
<tr>
<td>8–11</td>
<td>2–3</td>
</tr>
<tr>
<td>12–18</td>
<td>2–3</td>
</tr>
<tr>
<td>Adults</td>
<td>2</td>
</tr>
</tbody>
</table>

From NHMRC (2003 a, b).

Both the Dietary Guidelines for Australian Adults and the Dietary Guidelines for Children and Adolescents recognise the important contribution fruit makes to a healthy diet and it is therefore included as one of the five core food groups (NHMRC 2003a, b). Within these guidelines there are specific recommendations for fruit intake (Table 1). It is worth noting that the recommendations reflect the minimum levels required for good health – greater fruit intake is permitted providing the requirements for the remaining core foods groups are satisfied and energy intake is not in excess to requirements.

However the 1995 National Nutrition Survey (McLennan & Podger 1995) highlights that on average only 47% adults over 19 years of age meet the recommended two servings of fruit per day. The Australian Guide to Healthy Eating also recognises the importance of fruit consumption and advises that a small glass of fruit juice can count towards a serve of fruit (DHFS 1998). If juice is included as a serve of fruit, a greater number of adults (approximately 70%), would reach the recommended daily target for fruit – a 49% increase.

As in the adult group, the average intake of fruit by most children and adolescents falls well below recommended levels. Table 2 illustrates the important role fruit juice plays in helping children achieve their daily recommended intake for fruit.

Table 2. Mean fruit intake of children and adolescents in relation to recommended levels.

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Percentage meeting recommended levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Including fruit juice</td>
</tr>
<tr>
<td>4–7</td>
<td>160</td>
</tr>
<tr>
<td>8–11</td>
<td>60</td>
</tr>
<tr>
<td>12–15</td>
<td>60</td>
</tr>
<tr>
<td>16–18</td>
<td>57</td>
</tr>
</tbody>
</table>

From Record (2001).
are typically not being met. Indeed, without fruit juice in
the diet, the ability of children, adolescents and adults to meet Government recommendations for fruit intake are significantly compromised.

Fruit juices and glycemic index
Fruit juices generally have a low glycemic index (GI) (Brand-Miller & others 2002). The glycemic index is a ranking of carbohydrate foods based upon their effect on blood sugar levels. Because carbohydrates in low glycemic index foods break down more slowly than in high glycemic index foods, there is a more gradual rise in blood sugar levels. Low glycemic index foods help people manage diabetes (Brand-Miller & others 2003) and may help with weight management (Ma & others 2005). In 1999, the World Health Organization (WHO) and Food and Agriculture Organization (FAO) recommended that people base their diets on low-GI foods in order to lessen the risk of coronary heart disease, diabetes and obesity (Glycemic Index Ltd 2007). In general, it is recommend that a low GI product be eaten with every meal.

The GI of some popular fruit juices are: orange 52, apple 40, pineapple 46 and grapefruit 48 (Brand-Miller & others 2002).

Nutrients delivered by fruit juice
Fruit juices provide a range of vitamins and minerals, including vitamin C, folate, potassium and antioxidants. The Australian Dietary Guidelines (NHMRC 2003a, b) advise, when choosing drinks, that “juice is a good source of fluid and some vitamins. Juice does contain kilojoules so enjoy in moderation”. These Guidelines recognise that juices are important in the delivery of fluid and nutrients such as vitamin C, folate, and polyphenols and in addition can count towards a serve of fruit daily.

Vitamin C
The 1995 National Nutrition Survey showed that in children’s diets, fruit juice provided 33% of the vitamin C and was a larger contributor of vitamin C to the diet than whole fruit. In combination, fruit juice plus whole fruit provided 50% of the vitamin C in children’s diets. Fruit juice alone provided almost 25% of the vitamin C intake for adults (Record 2001).

Vitamin C is a water soluble vitamin and has an important role in wound healing and collagen formation. In addition, vitamin C increases iron absorption from meals (Garrow & others 2003). Research suggests that including fruit juice with foods increases iron bioavailability twofold (Fairweather-Tait & others 1995). In addition, the potential role of vitamin C in the prevention of chronic disease has been highlighted in the recently released Nutrient Reference Values for Australia and New Zealand (NHMRC 2006), where Suggested Dietary Targets for vitamin C are 220 mg per day for men and 190 mg per day for women in order to reduce chronic disease risk. These high levels for vitamin C reinforce the considerable scientific evidence showing a protective role for the nutrient. A standard glass of orange juice provides approximately 80 mg of vitamin C.

Phytonutrients
Increased attention has been given in the past decade to possible therapeutic effects of polyphenols (Scalbert & Williamson 2000). Polyphenols can act as antioxidants to protect the body’s tissues against oxidative stress (and against diseases associated with oxidative damage such as cancer and cardiovascular disease). Associations between polyphenol-rich foods and reduction of specific health conditions include lycopene in tomatoes reducing the incidence of prostate cancer (Campbell & others 2004), cranberry juice reducing the incidence of urinary tract infections in women (Jepson & others 2004) and grape juice having beneficial effects on markers of coronary heart disease (Freedman & others 2001, Folts 2002). The role of polyphenols in brain functions such as learning and memory has also received attention (Tanchotchou & others 2005, Chan & others 2006). Polyphenolics such as s-allylcysteine, s-allymercaptocysteine, allicin and diallosulphides (from garlic and red bell pepper) as well as epicatechin and catechin (found in tea) have all been shown to have some beneficial effects in animal models (Baghurst 2003).

A recent Australian review (Baghurst 2003) highlighted polyphenolic compounds as important for:

- Antioxidant properties, ie ability to scavenge naturally occurring free radicals before they can damage macromolecules directly or indirectly involved in either cell proliferation (relevant to carcinogenesis) or lipid metabolism (relevant to cardiovascular disease).
- Blocking formation of carcinogenic nitrosamines arising from the reaction of dietary nitrates/nitrites with secondary amines and amides in the stomach.
- Capacity to act as electrophile traps. In much the same manner in which they can scavenge nucleophilic free radicals, many plant phenols can also absorb highly reactive electrophiles thereby preventing damage to cellular components.
- Inhibiting generation of prostaglandins from arachidonic acid, and thereby retarding a ‘promotional’ phase of carcinogenesis.

The intake of polyphenols in the diet is about 1g/day (Scalbert & Williamson 2000), the major sources being fruit juices, red wine, coffee and tea. Juices are particularly high in flavonoids, a subclass of polyphenols. One orange has over 170 different phytochemicals, including more than 60 flavonoids, many of which have been shown not only to have antioxidant effects but also anti-inflammatory and anti-tumour activity. These substances contribute to optimal health and may protect against some of the common chronic diseases such as cancer and cardiovascular disease, degenerative eye and cognitive conditions and general damage caused by aging (Baghurst 2003).

Folate
Folate is an essential vitamin and has an important role in cell production. Fruit and vegetable juices are significant contributors to folate intake in the Australian diet, particularly for children, providing 9.1% of total folate intake for 2–11 year olds, 8.5% for 12–18 year olds and 4.5 % for adults (NHMRC 2003b). Folate is also important for women of child bearing age where folate deficiency is linked to neural tube defects (Wald & others 1991). Folate also has important implications in heart health as it has been demonstrated to lower homocysteine levels (Boushey & others 1995). Elevated homocysteine levels have been shown to be an independent risk factor for cardiovascular disease (Homocysteine Studies Collaboration 2002).
The recently released Nutrient Reference Values for Australia and New Zealand (NHMRC 2006) highlights the importance of folate for chronic disease reduction and acknowledges that current intakes are well below the new recommended intakes. The Suggested Dietary Target for folate is some 100–400 µg Dietary Folate Equivalents (DFE) over current intakes and is designed to maximise homocysteine levels, reduce overall chronic disease risk and DNA damage. Fruit juice is a natural source of folate. Moreover, with the fortification of fruit juice with folate the public has an additional means of achieving higher intakes of this vitamin. Indeed, this fact was acknowledged in the Nutrient Reference Value’s report with a greater contribution of folate derived from orange juice enriched with this vitamin (NHMRC 2006).

**Potassium**

Potassium is the major cation of the intracellular fluid. The movement of potassium out of cells, and sodium in, changes electrical potentials in nerves and muscles to allow them to function effectively (Baghurst 2003).

Many fruit juices such as orange juice are important sources of potassium. The Suggested Dietary Target (NHMRC 2006) for potassium is 4700 mg/day (men and women) to take advantage of potassium’s ability to blunt the effect of sodium on blood pressure and protect against the development of renal stones. Fruit and vegetable consumption has been demonstrated to help reduce blood pressure, particularly in hypertensive individuals (Appel & others 1997, John 2002). Dietary advice for blood pressure management includes a diet rich in fruit and vegetables (Guidelines Committee 2003). There is sufficient evidence from experimental studies about the role of potassium in regulating blood pressure that the US allows a health claim related to this (National Academy of Sciences 1989).

**Dietary fibre**

Increasing dietary fibre has been linked to lower rates of obesity, cardiovascular disease, diabetes and certain cancers and the Suggested Dietary Targets (NHMRC 2006) for fibre (38 g/day for men and 28 g/day for women) highlight the need to consume a wide range of fibre containing foods and beverages each day. Some fruit juices currently available contain dietary fibre and as such can provide an additional fibre source to help optimise overall fibre intake.

Clearly, 100% fruit juice is a nutrient dense beverage and as such is an important part of a varied and healthy diet as it contributes a range of nutrients as well as phytonutrients vital for good health and disease prevention.

**Fruit juice and the Australian Guide to Healthy Eating**

The Australian Guide to Healthy Eating is the only National Government endorsed healthy eating guide. The Federal Budget announced in May 2007 provided funding for the Department of Health and Ageing to review the guide along with the Australian Dietary Guidelines for Children and Adolescents as well as the Core Food Groups.

Currently, a serve of fruit juice is included as an option within the fruit servings of the Australian Guide to Healthy Eating. Table 2 illustrates the contribution fruit juice makes in helping all segments of the Australian population meet the Government recommendation for fruit intake. There is a 49% increase in the number of adults meeting the recommended fruit servings when fruit juice is included.

In addition, the CSIRO analysis (Record 2001) has confirmed the direct nutrient contribution fruit juice makes to the Australian diet with, as an example, 33% of the vitamin C in children’s diet derived from fruit juice while adults derive 25% of their vitamin C from juice.

A simple nutrient comparison of popular fruit juices and their whole fruit counterparts in Table 3 reveals that their nutritional contributions are essentially similar and as such supports the current advice in the Australian Guide to Healthy Eating that a 125 mL serve of fruit juice can be considered as a fruit serve.

It is of interest that fruit juices and whole fruits listed in Table 3 do not differ markedly in energy value or sugars content. These, and other minor differences notwithstanding, apart from dietary fibre, the nutritional similarities support the recommendation in the current eating guide, that a serve of fruit juice can be included.

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**Table 3. Nutrient comparison of popular whole fruit and the fruit juice counterpart.**

<table>
<thead>
<tr>
<th>Product</th>
<th>Water (g)</th>
<th>Energy (kJ)</th>
<th>Avail Carb (g)</th>
<th>Sugars (g)</th>
<th>Fibre (g)</th>
<th>Beta Carotene Eq (µg)</th>
<th>Vit C (mg)</th>
<th>Folate (µg)</th>
<th>Calcium (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>85.3</td>
<td>185</td>
<td>9.0</td>
<td>9.0</td>
<td>2.1</td>
<td>75</td>
<td>50</td>
<td>n/a</td>
<td>29</td>
<td>170</td>
</tr>
<tr>
<td>Orange Juice</td>
<td>89.7</td>
<td>148</td>
<td>8.2</td>
<td>7.9</td>
<td>0.1</td>
<td>93</td>
<td>49</td>
<td>40</td>
<td>8</td>
<td>156</td>
</tr>
<tr>
<td>Pineapple</td>
<td>86.8</td>
<td>178</td>
<td>8.2</td>
<td>8.2</td>
<td>1.8</td>
<td>21</td>
<td>17</td>
<td>n/a</td>
<td>20</td>
<td>151</td>
</tr>
<tr>
<td>Pineapple Juice</td>
<td>88</td>
<td>183</td>
<td>10.3</td>
<td>10.3</td>
<td>-</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td>6</td>
<td>143</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>88.3</td>
<td>138</td>
<td>5.4</td>
<td>5.4</td>
<td>1.7</td>
<td>14</td>
<td>40</td>
<td>14</td>
<td>24</td>
<td>135</td>
</tr>
<tr>
<td>Grapefruit Juice</td>
<td>91.4</td>
<td>120</td>
<td>6.0</td>
<td>6.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>61</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Grape</td>
<td>79.6</td>
<td>284</td>
<td>15.5</td>
<td>15.5</td>
<td>2.4</td>
<td>108</td>
<td>5</td>
<td>-</td>
<td>14</td>
<td>221</td>
</tr>
<tr>
<td>Grape Juice</td>
<td>85.5</td>
<td>221</td>
<td>13.4</td>
<td>13.4</td>
<td>-</td>
<td>24</td>
<td>2</td>
<td>8</td>
<td>8</td>
<td>85</td>
</tr>
<tr>
<td>Apple</td>
<td>83.8</td>
<td>236</td>
<td>12.8</td>
<td>12.4</td>
<td>2.2</td>
<td>14</td>
<td>6</td>
<td>-</td>
<td>5</td>
<td>106</td>
</tr>
<tr>
<td>Apple Juice</td>
<td>88.9</td>
<td>167</td>
<td>10.1</td>
<td>10.1</td>
<td>-</td>
<td>4</td>
<td>45</td>
<td>4</td>
<td>4</td>
<td>84</td>
</tr>
</tbody>
</table>

a = raw peeled; b = unpeeled raw; c = sweetened, added vit c; d = white grapes; e = added vit c. From NUTTAB (2006).
in the fruit recommendations, although whole fruit is correctly emphasised for its fibre contribution.

Recently both the United States and Canada have reviewed and updated their respective diet education guides and both countries have retained a serve of fruit juice within the fruit recommendations. The MyPyramid food guidance plan in the USA states that, “Any fruit or 100 percent fruit juice counts as part of the fruit group” and that no more than one third of the total recommended fruit group intake be derived from juice (USDA 2005). Similarly, Canada’s food guide retains 100% fruit juice (half a cup) within their vegetables and fruit group and advises consumption of vegetables and fruit more than juice (Health Canada 2007).

Categorisation of fruit juices
It is apparent that there is a lack of scientific rigour in the categorisation of beverages in Australia, including fruit juice. A recent Deakin University study (Sanigorski & others 2007), as well as the Victorian schools “Go For Your Life” program, inappropriately classified fruit juices as “sweetened drinks”.

However, the recently published American beverage guidelines carefully considered the energy, nutrient and functional contributions of a range of beverages in order to develop a clear set of definitions for the range of beverages available for consumption. According to their analysis, “sweetened beverages” refer to any beverage to which a calorific sweetener has been added, eg soft drinks and fruit drinks. This clearly excludes and differentiates products where sugars are naturally present in liquid foods, such as fruit juices. The specific definitions developed by the beverage guidance panel (Popkin 2006) include:

• Sweetened Beverages: Any beverage to which a caloric sweetener has been added, including carbonated or noncarbonated soft drinks, fruit punch, fruit drinks, lemonade, sweetened powder drinks, or any other nonartificially sweetened beverages. Excluded from this definition are sugars naturally present in fluids and that are not added in processing, in preparation, or at the table.

• Fruit and Vegetable Juices: Beverages that are composed exclusively of an aqueous liquid or liquids extracted from one or more fruits or vegetables with no added caloric sweeteners.

It is important that studies investigating the role of fruit juice in health, as well as those involved in food education, make a clear distinction between the beverage categories they are considering and in this regard the American beverage guidance definitions may prove useful. Fruit juices are not sweetened drinks and should not be categorised as such. To do so disregards the nutritional contribution that fruit juice makes to the Australian diet, a contribution recognised by the Government in the Australian Guide to Healthy Eating (DHFS 1998).

Fruit juice and dental health
The metabolism of fermentable carbohydrates (which includes sugars from fruit, fruit juice and starchy foods) plays a part in the dental caries or erosion process (Moynihan 2005). It is also well documented (Konig & Naria 1995, Ruxton & others 1997) that many other factors are involved, including:

• The form of food or fluid
• Duration of exposure to sugars
• Nutrient composition of foods
• Sequence of eating
• Salivary flow
• Presence of buffers
• Oral hygiene

Since the introduction of fluoride, the incidence of caries worldwide has decreased, despite consumption of sugars remaining at similar levels (Konig & Nivia 1995). Recent data from South Australia may indicate a rise in dental caries in Australian teenagers which may be due to the increased consumption of non-fluoridated bottled water and/or sugary/sports drinks and/or poor eating habits (AIHW 2006). In fact, comparisons of international data show that less dental caries do not necessarily exist where the consumption of sugar is low. Similarly, higher consumption of sugar does not equate to more dental caries (Ruxton & others 1999).

In the latter reference, an Italian study reports that good oral hygiene was three times more likely to predict low caries prevalence than a low cariogenic diet. This is also supported by a cross sectional survey whose findings suggested that regular brushing with fluoride toothpaste may have greater impact on dental caries in young children than restricting sugary foods (Gibson & Williams 1999). Australia has one of the lowest levels of dental caries in children (Armfield & others 1999).

Fruit juices, fruit, sports drinks, soft drinks, wine and pickles are often perceived as problem foods for dental health because of their acidity. The Australian Dental Association policy states that acidic foods should be avoided when individuals are at high risk of developing caries, such as individuals with disease, athletes with a dry mouth and sipping drinks during interrupted sleep (ADA 2002). To reduce the impact of the acid in drinks the Australian Dental Association (Vic Branch) recommends (ADA 2006):

• Do not hold or “swish” the drink around the mouth
• Use a straw to reduce exposure to the teeth
• Consume chilled drinks as this can reduce erosion.

New Zealand Ministry of Health guidelines for serving juice to children (NZMOH 2003) recommend:

1–2 years dilute juice at least 1 part juice to 3 parts water
2–5 years dilute juice at least 1 part juice to 1 part water and encourage drinking juice with meals rather than between
6–12 years: one glass of fruit juice, taken with meals.

The New Zealand Juice and Beverage Association (2007) advise to drink juice in conjunction with food as the saliva generated by eating helps to protect teeth by washing fruit sugar and acid away. This, along with brushing teeth regularly, helps minimise the possibility of dental cavities caused by sweet food or drink.

Dietary Guidelines in Australia recommend moderate intake of sugars and foods containing sugars. A diet void of naturally occurring sugars and fermentable carbohydrates is not feasible, and a diet void of added sugars would be difficult to achieve and maintain (Touger-Decker & van Loveren 2003). However dental health can be maintained, if juice is consumed appropriately as part of a healthy diet along with good oral hygiene practices;
Fruit juice and healthy bodyweight

Recent statistics have shown that obesity levels within Australia have increased in the past 10 years with 62% of men and 45% of women overweight or obese (DOHA 2007). The cause of obesity is not a single food or food group as often portrayed. While many factors can influence an individual’s weight, the maintenance of body weight requires a balance between total energy ingested and total energy expended. Increases in body weight and body fat content occur only when chronic energy intake exceeds energy expenditures (Hill & Prentice 1998).

A CSIRO analysis of the National Nutrition Survey (Record 2001) indicated that on average an Australian male consumes 70 mL of fruit juice daily and female 63 mL daily. Children’s intake of juice varies between 84 mL and 120 mL depending upon the age and sex of the child. Considering only those who actually consumed fruit juice on the day of the survey, average intakes ranged from 263–327 mL across all segments of the population (children, adolescents and adults). However, in common with most dietary components, some individuals have higher intakes, reinforcing the importance of sensible fruit juice consumption as part of a balanced diet with regular physical activity.

In terms of average total energy derived from fruit juice, the CSIRO analysis in Table 4 revealed that fruit juice provided 2% of total energy to 2–18 year olds and 1% of energy to adults over 19 years (Record 2001). Thus the analysis of the National Nutrition Survey reveals that the average energy contribution of fruit juice across all age segments is consistent with a healthy diet.

Studies that have looked specifically at fruit juice consumption and obesity have shown mixed results (Skinner 1999, Newby & others 2004, Fulgoni & others 2007). Some studies have found an association between juice intake in excess of current advice in the Australian Guide to Healthy Eating to include fruit juice as an option within the fruit recommendations – with whole fruit emphasised. Indeed, this advice should be retained in the soon to be up-dated version of the Guide.

Release of the Nutrient Reference Values has changed the nutritional landscape in Australia with revised (in most cases increased) nutrient requirements and heavy emphasis on plant-based products – particularly in relation to reducing the risk of chronic disease. The Nutrient Reference Value report highlights the opportunity for fruit juice to play a role in the delivery of nutrients identified as important to health and disease prevention. The rapid emergence of phytonutrients and specifically polyphenols, of which fruit juice is a useful supplier, in the maintenance of health as well as disease reduction, reinforces the value of optimising the intake of these compounds and should be factored into general dietary advice including the revision of the Australian Guide to Healthy Eating.
The scientific research on fruit juice facilitates the development of general messages regarding the role of fruit juice in the diet. These messages, while necessarily broad, can place fruit juice consumption in an appropriate context and can be used by industry to reflect a responsible approach to the issue. One such message may be:

“One or two moderate serves of fruit juice can be included as part of a healthy, varied and balanced diet that also includes regular physical activity. Industry recommends the sensible consumption of all foods – including fruit juice. A glass of fruit juice counts towards a portion of fruit each day although whole fruit is encouraged for its fibre content.”

References


Chalmers, G & others. 1999. Fruit juice consumption and the development of general messages regarding the role of fruit juice in the diet. These messages, while necessarily broad, can place fruit juice consumption in an appropriate context and can be used by industry to reflect a responsible approach to the issue. One such message may be:

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References


