



**JOINT FAO/WHO FOOD STANDARDS PROGRAMME**  
**CODEx COMMITTEE ON METHODS OF ANALYSIS AND SAMPLING**

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**REVIEW OF METHODS OF ANALYSIS IN CXS 234**  
**FRUIT JUICES WORKABLE PACKAGE)**

*(Prepared by IFU)*

**INTRODUCTION**

1. CCMAS as part of its ongoing work to ensure that methods of analysis in the *Recommended methods of analysis and sampling* (CXS 234-1999) are current and fit-for- purpose, has been reviewing the fruit juices workable package.
2. Work on the review of these methods was first undertaken by an EWG chaired by Germany and the report of this EWG was considered by CCMAS44.<sup>1</sup>
3. At CCMAS44, certain methods were endorsed and/or revoked, while other methods required further consideration.
4. CCMAS44 agreed that an expert group under the auspices of IFU would consider the aforementioned methods, including those methods for which there are no numerical provisions in the *General standard for fruit juices and nectars* (CXS 247-2005), and prepare a discussion paper for consideration by CCMAS45.<sup>2</sup>
5. The terms of reference of the expert group is presented in REP25/MAS, paragraph 70.
6. The expert group would prepare a discussion paper on which methods in CXS 234-1999 and CXS 247-2005 are still considered important and fit-for-purpose, in their expert opinion, and which methods should be mainlined in CXS 234-1999, revoked, or replaced.
7. The full report of this expert group is presented in Appendix IV.

**EXPERT GROUP PROCESS AND RESULTS**

8. IFU convened the expert group made up of producers and users of fruit juices, government representatives, laboratories and kit manufacturers working in the fruit juice area (list of experts is presented in the expert group report in Appendix IV). The expert group held several meetings for the assessment of the methods in CXS 247-2005 and CXS 234-1999.
9. Relevant Standards Development Organisations (SDOs) provided copies of methods to assist the expert group in the assessment of methods. However, experts did not have sight of ISO methods and thus these methods (presented in Appendix III) could not be assessed at this time.
10. Of the methods assessed, 4 were proposed for revocation (removal from CXS 234-1999 and/or CXS 247-2005), either because they were no longer supported by the SDO or were considered by the group to not meet the requirements of the standards or were no longer required. These methods are presented in Appendix II).
11. The expert group further proposed retention in CXS 234-1999 of 52 methods that are fit-for-purpose and proposals for amendments to some provisions, splitting of entries and correction of nomenclature. These methods are presented in Appendix I.
12. A further set of methods, all based on enzymatic procedures, were all validated against a specific kit. Although in the IFU methods all the reagents, enzymes and times etc are specified in procedures, there are concerns about the specificity of the available enzymes. It is therefore proposed that a decision on this set of methods

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<sup>1</sup> REP25/MAS, paras 49 - 71

<sup>2</sup> REP25/MAS, para 70

should be postponed to CCMAS46 in 2027 to allow further review. These methods are presented in Appendix III.

13. Due to time constraints, the expert group did not make any recommendations for the endorsement of new methods that should be considered by CCMAS. There are methods that could be considered and can be introduced using the regular process for submission of methods for consideration by either the commodity committee (CCPFV) or CCMAS.

### CONCLUSIONS AND RECOMMENDATIONS

14. The expert group noted ongoing issues that have been detected with the adulteration of fruit juices prior to and after publication of CXS 247 in 2005.
15. The expert group concludes that the logic applied in 2005, when the methods were initially approved, is still relevant today and there is still a need to have internationally approved methods that can be used by Governments and other interested parties to ensure that the consumer is not sold mis-represented products.
16. The expert group further concludes that:
  - a. Methods listed in Table 1 of Appendix IV should not be transferred from CXS 247 to CXS 234 and therefore be revoked as these methods are no longer supported by their SDOs or are no longer used in the control of fruit juices.
  - b. Of the 56 methods assessed, 52 methods are still considered “fit-for-purpose” and should be transferred or retained in CXS 234. These methods are listed in Table 2 of Appendix IV.
  - c. Two (2) pH methods presently listed in CXS 247 should be listed together with the / nomenclature as the methods are the same but written by different SDOs. These are listed in Table 3 of Appendix IV.
  - d. Some methods presently listed under the same provision are no longer the same as different column types etc. are used and so can no longer be given the / nomenclature. The procedures are considered acceptable and are likely to give similar results, as they are based on HPLC-RI procedures, but are clearly different. CCMAS should therefore consider one as a Type II procedure and the other as Type III as detailed in Table 3.
  - e. Due to changes in the supply kits, many of the enzymatic based kits used in the collaborative trials in the 90s are no longer commercially available, although other versions of the kits using different materials are still available. CCMAS is requested to postpone discussion on these methods until CCMAS46 IN 2027 to allow experts further time to fully evaluate the options available as some of the procedures cover critical authenticity parameters and there are presently no validated HPLC based methods available to use in their stead. These methods are listed in Table 5 of Appendix IV.
  - f. AOAC, IFU and NMLK all provided copies of their methods to the expert group so that a thorough assessment of the procedures could be made. However, since the expert group were not given sight of the methods published by ISO no conclusions could be made concerning these procedures. CCMAS should therefore consider not retaining these methods in or transferring them to CXS 234.
17. CCMAS45 is invited to consider:
  - a. Endorsement of the methods presented for revocation, retention and amendments as presented in Appendices I and II; and
  - b. Retention of the methods in CXS 234 and/or CXS 247 pending further review (Appendix III) or revocation of the ISO methods in Appendix III.

## APPENDIX I

## AMENDMENTS AND REVOCATIONS TO CXS 234-1999 RECOMMENDED BY THE EXPERT GROUP

(For CCMAS' consideration and endorsement)

Note: Amendments are indicated in **bold**, ~~strike through~~ and/or underline. Revocations are indicated in **red**. The columns "Juice Min (g/l)", "Juice Max (g/l)" and "Comments" are only for information.

Commodity	Provision	Method	Principle	Type	Juice Min (g/l)	Juice Max (g/l)	Comments
<del>Fruit juices and nectars</del>	<del>Pectin (additives)</del>	<del>IFUMA-26</del>	<del>Precipitation / photometry</del>	<del>I</del>			Lack of validation data
<del>Fruit juices and nectars</del>	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del>	<del>Determination of stable hydrogen isotope ratio of water from fruit juices ENV 12142</del>	<del>Stable isotope mass spectrometry</del>	<del>II</del>			No longer supported by CEN
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Vitamin C (dehydro-ascorbic acid and ascorbic acid) (Quality / Authenticity)</u>	<del>Determination of vitamin C (dehydro-ascorbic acid and ascorbic acid)</del> AOAC 967.22	Microfluorometry	III	0.02	0.5	Unless declared as an additive
Fruit juices and nectars	Ascorbic acid-L <u>(additives)</u>	IFU 17a	HPLC- <u>UV</u>	II	0.02	0.5	unless declared as an additive
Fruit juices and nectars	Ascorbic acid-L <u>(additives)</u>	AOAC 967.21 / ISO 6557-2	<u>Titrimetry</u> (Indophenol method)	III	0.02	0.5	unless declared as an additive

<sup>xx</sup> **3.4 Verification of composition, quality and authenticity**

Fruit juices and nectars should be subject to testing for authenticity, composition and quality where applicable and where required. The analytical methods used should be those found in Section 9 (Methods of analysis and sampling).

The verification of a sample's authenticity/quality can be assessed by comparison of data for the sample, generated using appropriate methods included in the standard, with that produced for fruit of the same type and from the same region, allowing for natural variations, seasonal changes and for variations occurring due to processing.

Commodity	Provision	Method	Principle	Type	Juice (g/l) Min	Juice (g/l) Max	Comments
Fruit juices and nectars	Ascorbic acid-L ( <b>additives</b> )	IFU 17b	<b>Potentiometric titrimetry (iodine) method</b>	III	0.02	0.5	unless declared as an additive
<b>Fruit juices and nectars</b>	<b>Determination of glucose, fructose, sucrose and sorbitol (additive / authenticity)</b>	<b>IFU 67</b>	<b>HPLC-RI</b>	<b>II</b>	S = traces, G = 3, F = 3	S = 110, G = 110, F = 110	Unless declared as an additive
<b>Fruit juices and nectars</b>	<b>Determination of glucose, fructose and sucrose (additive / authenticity)</b>	<b>NMKL 148</b>	<b>HPLC-RI</b>	<b>III</b>	S = traces, G = 3, F = 3	S = 110, G = 110, F = 110	Unless declared as an additive
<del>Fruit juices and nectars</del>	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005*</del>	<del>Determination of glucose fructose and saccharose</del> <del>EN 12630</del> <del>IFUMA 67 NMKL 148</del>	<del>HPLC</del>	<del>II</del>			
Fruit juices and nectars	Quinic, malic and citric acid in cranberry juice cocktail and apple juice ( <b>permitted ingredients and additives</b> ) ( <b>Quality / Additive / Authenticity</b> )	<b>Determination of quinic, malic and citric acid in cranberry juice cocktail and apple juice</b> AOAC 986.13	<b>HPLC-UV</b>	III	Q = 5 CJ, C = 5 CJ, M = 5 CH, Q = traces AJ, C = 0.05 AJ, M = 2 AJ	Q = 15 CJ, C = 15 CJ, M = 10 CJ, Q = traces AJ, C = 0.2 AJ, M = 8 AJ	Unless declared as an additive
<del>Fruit juices and nectars</del>	<del>Sucrose (permitted ingredients) (Additive / Authenticity)</del>	<del>EN 12630</del> <del>IFUMA 67</del> <del>NMKL 148</del>	<del>HPLC-RI</del>	<del>II</del>	<del>1 (II?)</del>	<del>110</del>	<del>Unless declared as an additive</del>
<b>Fruit juices and nectars</b>	<b>Sucrose (Additive / Authenticity)</b>	<b>NMKL 148</b>	<b>HPLC-RI</b>	<b>III</b>	Traces	110	Additive

Commodity	Provision	Method	Principle	Type	Juice (g/l) Min	Juice (g/l) Max	Comments
Fruit juices and nectars	Tartaric acid in grape juice <del>(additives)</del> <u>(Quality/Additive/Authenticity)</u>	<del>EN 12137</del> IFUMA 65	HPLC- <u>UV</u>	II	nd except grape = 1	7 in grape	unless declared as an additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Fermentability (Quality/Authenticity)</u>	<del>Determination of fermentability</del> IFUMA 18	Microbiological method	I		positive or negative	Grandfather the method
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Anthocyanins (Quality/Authenticity)</u>	<del>Detection of anthocyanins</del> IFUMA 71	HPLC- <u>UV</u>	I	No minimum	Nor maximum	pattern is critical
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Beet sugar in fruit juices (Authenticity)</u>	<del>Detection of beet sugar in fruit juices</del> AOAC 995.17	<u>Magnetic Resonance spectrometry (D-NMR)</u> <del>Deuterium NMR</del>	II	Depends on juice	Depends on juice type	provided no sugars added
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>C<sup>13</sup>/C<sup>12</sup> ratio of ethanol derived from fruit juices (Authenticity)</u>	<del>Determination of C<sup>13</sup>/C<sup>12</sup> ratio of ethanol derived from fruit juices</del> JAOAC 79, No. 1, 1996, 62-72	<del>Stable isotope mass spectrometry</del> <u>IRMS</u>	II	-11 permil	-28 permil	juice dependant & provided no added C <sub>4</sub> sugars
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Carbon stable isotope ratio of apple juice (Authenticity)</u>	<del>Determination of carbon stable isotope ratio of apple juice</del> AOAC 981.09 - JAOAC 64, 85 (1981)	<del>Stable isotope mass spectrometry</del> <u>IRMS</u>	II	-23 permil	-26 permil	juice dependant & provided no C <sub>4</sub> sugars added

Commodity	Provision	Method	Principle	Type	Juice (g/l) Min	Juice (g/l) Max	Comments
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Carbon stable isotope ratio of orange juice (Authenticity)</u>	<del>Determination of carbon stable isotope ratio of orange juice</del> AOAC 982.21	<del>Stable isotope mass spectrometry IRMS</del>	II	-23 permil	-26 permil	juice dependant & provided no C4 sugars added
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Carotenoid, total/individual groups (Authenticity)</u>	<del>Determination of carotenoid, total/individual groups</del> <del>EN 12136;</del> IFUMA59	Spectrophotometry	I	0.05	0.3	
Fruit juices and nectars	<u>Cellobiose (Quality/Authenticity)</u>	IFUMA 4	<del>Capillary gas chromatography</del> <u>Cap-GC-FID</u>	IV	nd < 0.01	20<	xs use of cellulases
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Formol number (Quality/Authenticity)</u>	<del>Determination of formol number</del> <del>EN 1133</del> IFUMA 30	Potentiometric titration	I	0.7	60	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Free amino acids (Quality/Authenticity)</u>	<del>Determination of free amino acids</del> <del>EN 12742</del> IFUMA 57	Liquid Chromatography	II	variable	variable	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Hesperidin and naringin (Quality/Authenticity)</u>	<del>Determination of hesperidin and naringin</del> <del>EN 12148</del> IFUMA 58	HPLC	II	250	750	Pulpwash detection

Commodity	Provision	Method	Principle	Type	Juice (g/l)	Min	Juice (g/l)	Max	Comments
Fruit juices and nectars	High Fructose Corn Syrup and Hydrolysed Inulin Syrup in apple juice <del>(permitted ingredients)</del> <b>(Additive/Authenticity)</b>	<del>Determination of HFCS and HIS by</del> <b>Capillary GC method</b> JAOAC 84, 486 (2001) / IFU recommendation No. 4	<b>CAP-GC-FID</b>	IV			< 0.025		provided no added sugar syrups
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b>Naringin and neohesperidin in orange juice (Quality/Authenticity)</b>	<del>Determination of naringin and neohesperidin in orange juice</del> AOAC 999.05	HPLC-UV	III			Nar < 1.2, neohes		
Fruit juices and nectars	Phosphorus/phosphate <b>(Quality/Additive/Authenticity)</b>	<b>EN-1136/</b> IFU 50	<b>Photometric determination Photometry</b>	II	0.04		0.36		Provided no declared phosphate added
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b>Proline by photometry – non-specific determination (Quality/Authenticity)</b>	<del>Determination of proline by photometry – non-specific determination</del> <b>EN-1141</b> IFUMA 49	Photometry	I	traces		2.1		
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b>Sodium, potassium, calcium, magnesium in fruit juices (Quality/Authenticity)</b>	<del>Determination of sodium, potassium, calcium, magnesium in fruit juices</del> <b>EN-1134</b> IFUMA 33	<del>Atomic absorption spectroscopy</del> <b>AAS</b>	II	Na = nd, K = 0.8, Mg = 0.02, Ca = 0.005		Na = 1.0, K = 4.60, Mg = 0.35, Ca = 0.55		

Commodity	Provision	Method	Principle	Type	Juice (g/l) Min	Juice (g/l) Max	Comments
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Stable carbon isotope ratio in the pulp of fruit juices (Authenticity)</u>	<del>Determination of stable carbon isotope ratio in the pulp of fruit juices</del> <del>ENV 13070</del> Analytica Chimica Acta 340 (1997) / <u>IFU 88</u>	<del>Stable isotope mass spectrometry</del> <u>IRMS</u>	II	-23.5 permil	-28.5 permil	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Stable carbon isotope ratio of sugars from fruit juices (Authenticity)</u>	<del>Determination of stable carbon isotope ratio of sugars from fruit juices</del> <del>ENV 12140</del> Analytica Chimica Acta 271 (1993) / <u>IFU 88</u>	<del>Stable isotope mass spectrometry</del> <u>IRMS</u>	II	-11.0 permil	-27.0 permil	Provided no declared cane/corn sugars added
<del>Fruit juices and nectars</del>	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del>	<del>Determination of stable oxygen isotope ratio in fruit juice water</del> <del>ENV 12141</del>	<del>Stable isotope mass spectrometry</del>	<del>II</del>	-8.0 permil	+ 11.0 permil	Only applicable to NFC juices & concentrates
<u>Fruit juices and nectars</u>	<u>Stable oxygen isotope ratio in fruit juice water (Authenticity)</u>	<u>IFU 89</u>	<u>IRMS</u>	<u>II</u>	-8.0 permil	+ 11.0 permil	Only applicable to NFC juices & concentrates
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Sugar beet derived syrups in frozen concentrated orange</u>	<del>Determination of sugar beet derived syrups in frozen concentrated</del>	<del>Oxygen isotope ratio analysis</del> <u>IRMS</u>	I	+3 permil	+ 11.0 permil	Only applicable to OJ concentrate



Commodity	Provision	Method	Principle	Type	Juice (g/l)	Min	Juice (g/l)	Max	Comments
	<u>juice <math>\delta^{18}\text{O}</math> measurements in water (Authenticity)</u>	<del>orange — juice <math>\delta^{18}\text{O}</math> Measurements in water</del> AOAC 992.09							
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Benzoic acid as a marker in orange juice for pulp wash (Quality/Authenticity)</u>	<del>Determination of benzoic acid as a marker in orange juice</del> AOAC 994.11	HPLC	III					Only detected in OJ if used as a marker for pulp wash or additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Chloride (expressed as sodium chloride) (Authenticity)</u>	<del>Determination of — chloride (expressed as sodium chloride)</del> <del>EN — 12133</del> IFUMA 37	Electrochemical titrimetry	III	traces		4.28		
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Fumaric acid (Quality/Authenticity)</u>	<del>Determination of fumaric acid</del> IFUMA 72	HPLC	II	0.001		<0.02		Levels above 20 ppm should be examined closely
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del> <u>Essential oils (Scott titration) (Quality/Authenticity)</u>	<del>Determination of essential oils (Scott titration)</del> AOAC 968.20 / IFUMA45 <sup>xxi</sup>	<del>(Scott)</del> Distillation, / titration	I	0.003		< 0.03		
<del>Fruit juices and nectars</del>	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005<sup>xx</sup></del>	<del>Determination of pH value</del> <del>NMKL-179</del>	<del>Potentiometry</del>	<del>II</del>	pH min 2.4		pH = 6.0		

<sup>xxi</sup> Because there is no numerical value in the standard, duplicate Type I methods have been included which may lead to different results.

Commodity	Provision	Method	Principle	Type	Juice (g/l) Min	Juice (g/l) Max	Comments
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>pH-value (Quality)</u>	<del>Determination of pH value</del> <del>EN 1132</del> IFUMA 11 / <del>NMKL 174 /</del> ISO 1842	Potentiometry	<del>IV</del> <del>II</del>	pH min 2.4	pH = 6.0	
Fruit juices and nectars	Soluble solids <u>(Quality)</u>	AOAC 983.17 / <del>EN 12143</del> / IFU 8 / ISO 2173	Indirect refractometry by	I	0	72	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Starch (Quality)</u>	<del>Detection of starch</del> AOAC 925.38 / IFUMA 73	Colorimetric	I		presences/absence test	grandfather the method
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Titrateable acids, total (Quality/Authenticity)</u>	<del>Determination of titrateable acids, total</del> <del>EN 12147</del> IFUMA 03 ISO 750	Titrimetry	I	0.3 (as ACA)*	90.0 (as ACA)*	
Fruit juices and nectars	Benzoic acid and its salts; sorbic acid and its salts <u>(Additive)</u>	IFUMA 63 / NMKL 124	HPLC-UV	II	nd	0.2 CJ	unless declared as an additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Ash in fruit products (Quality/Authenticity)</u>	<del>Determination of ash in fruit products</del> AOAC 940.26; / <del>EN 1135</del> ; IFUMA 9	Gravimetry	I	1	10	Provided no minerals added
Fruit juices and nectars	Sulphur dioxide (additives)	Optimized Monier Williams AOAC 990.28 / IFUMA 7A <del>NMKL 132</del>	Titrimetry (after distillation)	II		< 0.01	Use as an additive

Commodity	Provision	Method	Principle	Type	Juice (g/l)	Min	Juice (g/l)	Max	Comments
<u>Fruit juices and nectars</u>	<u>Sulphur dioxide (additives)</u>	<u>NMKL 132</u>	<u>Spectrophotometric (after distillation)</u>	<u>III</u>			< 0.01		Additive

\*ACA = anhydrous citric acid

## APPENDIX II

## METHODS RECOMMENDED FOR REVOCATION IN CXS 247-2005 AND NOT TO BE ENDORSED FOR INCLUSION IN CXS 234-1999

(For CCMAS' consideration)

Provision	Method	Principle	Type	Comments
<del>Vitamin C (Sections 3.2 Quality criteria and 3.3 Authenticity)<sup>a</sup></del>	<del>EN 14130 (2004)</del>	<del>High performance liquid chromatography (HPLC)</del>	<del>II</del>	No longer supported by CEN
<del>Pectin (Section 4 Additives)</del>	<del>IFU Method No. 26 (1964/1996)</del>	<del>Precipitation / photometry</del>	<del>I</del>	Lack of validation data
<del>Stable hydrogen isotope ratio of water from fruit juices (Sections 3.2 Quality criteria and 3.3 Authenticity)<sup>a</sup></del>	<del>ENV 12142 (1997)</del>	<del>Stable isotope mass spectrometry</del>	<del>II</del>	No longer supported by CEN
<del>Carbon dioxide (Sections 4 Additives and 5 Processing aids)</del>	<del>IFU Method No. 42 (1976)</del>	<del>Titrimetry (back-titration after precipitation)</del>	<del>IV</del>	No longer supported by IFU

<sup>a</sup> See Section 3.4 – Verification of composition, quality and authenticity.

## APPENDIX III

## METHODS RETAINED IN CXS 234-1999 AND CXS 247-2005 PENDING FURTHER REVIEW

(For CCMAS' information)

## Part 1: Methods retained in CXS 234-1999

Note: The expert group discussed some amendments to the format and presentation of the methods. While no recommendations have been made on the endorsement of these methods, the changes discussed to the format and presentation are indicated in **bold**, ~~strike through~~ and/or underline only for information.

Commodity	Provision	Method	Principle	Type	Juice Min (g/l)	Juice Max (g/l)	Comments
Fruit juices and nectars	Ascorbic acid-L	ISO 6557-2	<u>Titrimetry</u> (Indophenol method)	III			
Fruit juices and nectars	Ascorbic acid-L	<b>ISO 6557-1</b>	Fluorescence spectroscopy	IV			
Fruit juices and nectars	Malic acid (additives)	AOAC 993.05	<del>HPLC</del> <b>and</b> Enzymatic determination <b>and</b> <del>HPLC</del>	III	0.2	15	Unless declared as an additive
Fruit juices and nectars	Malic acid-D	IFUMA 64	Enzymatic determination	II		< 0.01	unless declared as an additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005</del> <b><u>Isocitric acid-D (Quality criteria / Authenticity)</u></b>	<del>Determination of isocitric acid-D</del> IFUMA 54	Enzymatic determination	II	traces	10	
Fruit juices and nectars	Citric acid <sup>xix</sup> (additives / <b><u>authenticity</u></b> )	IFUMA 22	Enzymatic determination	III	0.05	75	unless declared as an additive

<sup>xx</sup> 3.4 Verification of composition, quality and authenticity

Fruit juices and nectars should be subject to testing for authenticity, composition and quality where applicable and where required. The analytical methods used should be those found in Section 9 (Methods of analysis and sampling).

The verification of a sample's authenticity/quality can be assessed by comparison of data for the sample, generated using appropriate methods included in the standard, with that produced for fruit of the same type and from the same region, allowing for natural variations, seasonal changes and for variations occurring due to processing.

<sup>xix</sup> All juices except citrus based juices.

Commodity	Provision	Method	Principle	Type	Juice Min (g/l)	Juice Max (g/l)	Comments
Fruit juices and nectars	Glucose-D and fructose-D <del>(permitted ingredients)</del> <b>(Additive / Authenticity)</b>	IFUMA 55	Enzymatic determination	II	G = 3 F = 3	G = 110 F = 110	unless declared as an additive
Fruit juices and nectars	Malic acid-L <b>(Additive / Authenticity)</b>	IFU 21	Enzymatic determination	II	0.2	10	unless declared as an additive
Fruit juices and nectars	Sucrose <b>(Additive / Authenticity)</b>	IFU 56	Enzymatic determination	III	1	110	unless declared as an additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b><u>L-malic/total malic acid ratio in apple juice (Quality/Authenticity)</u></b>	<del>Determination of L-malic/total malic acid ratio in apple juice</del> AOAC 993.05	Enzymatic determination and HPLC	II		Ratio ≤ 1.05	unless malic is declared as an additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b><u>Sorbitol-D (Quality / Authenticity)</u></b>	<del>Determination of sorbitol-D</del> IFUMA_62	Enzymatic determination	II	traces	25	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b><u>Acetic acid (Quality / Authenticity)</u></b>	<del>Determination of acetic acid</del> IFUMA 66	Enzymatic determination	II	0.01	0.5	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <b><u>Alcohol (ethanol) (Quality)</u></b>	<del>Determination of alcohol (ethanol)</del> IFUMA 52	Enzymatic determination	II	traces	3	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3</del>	<del>Determination of gluconic acid</del>	Enzymatic determination	II	0.01	< 1.3	

Commodity	Provision	Method	Principle	Type	Juice Min (g/l)	Juice Max (g/l)	Comments
	<del>Authenticity of CXS 247-2005**</del> <u>Gluconic acid (Quality)</u>	IFUMA 76					
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Glycerol (Quality)</u>	<del>Determination of glycerol</del> IFUMA-77	Enzymatic determination	II	0.01	<1.3	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Lactic acid- D and L (Quality)</u>	<del>Determination of Lactic acid- D and L</del> IFUMA-53	Enzymatic determination	II	0.2	0.5	
Fruit juices and nectars	Sulphur dioxide (additives)	NMKL 135	Enzymatic determination	III		< 0.01	unless declared as an additive
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>pH-value (Quality)</u>	<del>Determination of pH value</del> ISO 1842	Potentiometry	<del>IV</del> II	pH min 2.4	pH = 6.0	
Fruit juices and nectars	Soluble solids <u>(Quality)</u>	ISO 2173	Indirect refractometry by	I	0	72	
Fruit juices and nectars	<del>Sections 3.2 Quality criteria and 3.3 Authenticity of CXS 247-2005**</del> <u>Titratable acids, total (Quality/Authenticity)</u>	<del>Determination of titratable acids, total</del> ISO 750	Titrimetry	I	0.3 (as ACA)*	90.0 (as ACA)*	

\*ACA = anhydrous citric acid

**Part 2: Methods retained in CXS 247-2005**

Note: All the methods are also found in CXS 234-1999 (see Part 1) although in a different format, and they have been transcribed below for completeness.

Provision	Method	Principle	Type
Ascorbic acid-L (Section 4 Additives)	ISO 6557-2:1984	Indophenol method	III
Ascorbic acid-L (Section 4 Additives)	ISO 6557-1:1986	Fluorescence spectroscopy	IV
Malic acid (Section 4 Additives)	AOAC 993.05	Enzymatic determination and high performance liquid chromatography (HPLC)	III
Malic acid-D	IFU Method No. 64	Enzymatic determination	II
Isocitric acid-D (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>3</sup>	IFU Method No. 54 (1984)	Enzymatic determination	II
Citric acid <sup>4</sup> (Section 4 Additives)	IFU Method No. 22 (1985)	Enzymatic determination	III
Glucose-D and fructose-D (Section 3.1.2 Permitted ingredients)	IFU Method No. 55 (1985)	Enzymatic determination	II
Malic acid-L	IFU Method No. 21 (1985)	Enzymatic determination	II
Sucrose (Section 3.1.2 Permitted ingredients)	IFU Method No. 56 (1985/1998)	Enzymatic determination	III
L-malic/total malic acid ratio in apple juice (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	AOAC 993.05	Enzymatic determination and high-performance liquid chromatography (HPLC)	II
Sorbitol-D (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	IFU Method No. 62 (1995)	Enzymatic determination	II
Acetic acid (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	IFU Method No. 66 (1996)	Enzymatic determination	II
Alcohol (ethanol) (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	IFU Method No. 52 (1996)	Enzymatic determination	II
Gluconic acid (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	IFU Method No. 76 (2001)	Enzymatic determination	II

<sup>3</sup> See Section 3.4 – Verification of composition, quality and authenticity.

<sup>4</sup> All juices except citrus based juices



Provision	Method	Principle	Type
Glycerol (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	IFU Method No. 77 (2001)	Enzymatic determination	II
Lactic acid-D and L (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	IFU Method No. 53 (1983/1996)	Enzymatic determination	II
Sulphur dioxide (Section 4 Additives)	NMKL 135 (1990)	Enzymatic determination	III
pH-value (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	ISO 1842:1991	Potentiometry	IV
Soluble solids	ISO 2173	Indirect by refractometry	I
Titrateable acids, total (Sections 3.2 Quality criteria and 3.3 Authenticity) <sup>a</sup>	ISO 750:1998	Titrimetry	I

## APPENDIX IV

**Recommendations from IFU expert group for  
consideration by CCMAS concerning fruit juice methods for authenticity and quality that are  
presently approved in *Recommended methods of analysis and sampling* (CXS 234-1999) and the  
*Standard for fruit juices and nectars* (CXS 247-2005) for retention and transfer to  
CXS 234-1999**

**Prepared by Dr D A Hammond  
Chair of IFU expert Working Group**

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### a) Executive summary

The IFU expert group was made up from producers and users of fruit juices, governmental representatives, laboratories and kit manufacturers who work in the fruit juice area. The group met 8 times for the assessment of the 74 methods listed in Codex Standards 247<sup>(5)</sup> (fruit juice and nectars) & 234 (standard of standard methods)<sup>(6)</sup>.

The group decided, due to many issue that have occurred with the authenticity of fruit juices over the years, and recently highlighted by IFU, it was important to retain internationally recognised methods within the Codex system to assist in controlling these products. Some examples of adulteration of fruit juices are listed in section 9 of this report.

The assessment of the authenticity and quality of a fruit juice generally depends on the analysis of a range of components in the product to determine if they are consistent with the product's description. The approach used by the standard development organisations (SDOs) for the procedure's validation was therefore suitable to ensure that the procedures were "fit for this purpose". Due to limited time, the group did not look at new methods for inclusion within the standard list and considered that these procedures could/should be added, when required, using the normal CCMAS approach.

Of the 56 methods assessed, 4 were proposed for delisting. This was either because they were no longer supported by the SDO, or were considered by the group to not meet the requirements of the standard, or were no longer required. These procedures are listed in Table 1.

The group recommends to CCMAS that the methods listed in Table 2 should be considered fit for purpose are still useful to control the quality and authenticity of juice samples and so should be transferred to the relevant section of the revised version of standard 234.

A further set of methods, all based on enzymatic procedures, were all validated against a specific kit. Although in the IFU methods all the reagents, enzymes and times etc are specified in procedures, there are concerns about the specificity of the available enzymes. Therefore, we would propose to CCMAS that a decision on this set of methods should be postponed until CCMAS in 2027, which will give the experts time to review and make a further proposal for that meeting.

### b) Recommendations from the IFU expert group for consideration to CCMAS

- 1) Although, the majority of suppliers of fruit juice are honest, there are generally a few who "bend/break the rules" and sell adulterated juices as pure. IFU warned its' members early in 2024 that there was a rising risk of adulterated products being offered to the market. It also advised its members to re-assess their mitigation strategies in light of this recent information.
- 2) The WG noted the ongoing issues that have been detected with the adulteration of fruit juices prior to and after publication of the Codex standard 247 in 2005 as illustrated in section 9 of this report.
- 3) It concludes that the logic applied in 2005, when the methods were initially approved, is still relevant today. It also concludes that there is still a need to have internationally approved methods that can be used by Governments and other interested parties to ensure that the consumer is not sold mis-represented products that are actually blends of cheaper materials (e.g. juice, sugars etc.) rather than 100 % pure juices.
- 4) The Expert Group has considered the methods listed in Table 1, are either no longer supported by their SDO, or are no longer used regularly in the control of fruit juices. We would therefore recommend to CCMAS they need **not** be transferred to the revised version of 234.
- 5) Of the 56 methods assessed 52 are still considered "fit for purpose" and the group recommends to CCMAS that these should be transferred to the revised version of 234. These methods are listed in Table 2 of the report.
- 6) The group also concludes that the two pH methods presently listed in 247 should be listed together with the / nomenclature as the methods are the same but written by different SDOs. These are listed in Table 3.
- 7) The group also concludes that some methods presently listed under the same provision are no longer the same as different column types etc are used and so can no longer be given the / nomenclature. The procedures are considered acceptable and are likely to give similar results, as they are based on

HPLC-RI procedures but are clearly different. Here we would propose to CCMAS that they should consider one as a type II procedure and the other as a type III method as detailed in Table 3.

- 8) Due to changes in the supply of kits, many of the enzymatic based kits used in the collaborative trials in the 90's are no longer commercially available, although other versions of the kits, using different materials are still available. The group would ask forbearance from CCMAS and that a decision on these methods should be held over until 2027, which gives the experts further time to fully evaluate the options available as some of the procedures cover critical authenticity parameters and there are presently no validated HPLC based methods available to use in their stead.
- 9) AOAC, IFU and NMKL all provided copies of their methods to members of the group so that a thorough assessment of the procedures could be made. However, as the WG were not given sight of the methods published by ISO no conclusions could be made concerning these procedures. We would thus suggest that CCMAS consider either revoking these methods or provide additional time to engage with the expert group if further time is approved by CCMAS 45 to consider the enzymic methods.

**c) Members and their affiliations who registered and participated in the IFU Expert Group**

Name	Post	Country/Association
Afranur ÖZÇOBAN	Department of Food Codex and Feed Legislation	Government of Turkey
Andrew Belmore	Science Laboratory Specialist	Canadian Food Inspection Agency (CFIA).
Asli Unsal	Committee Manager	ISO
Berrak Boz	Chair of the ISO subcommittee on fruit and vegetables (ISO/TC 34/SC 3)	ISO
Constance Bahr	Senior Manager, Official Methods Program	AOAC
David Hammond	Chair IFU representative at CCMAS	IFU/UK
Deborah McKenzie	Deputy Assistant Executive Director & Chief Standards Officer	AOAC
Fernanda Rodrigues Spinelli	Laboratório de Referência Enológica - LAREN/DIPOV/DDV/SEAPI	Brazilian Oenology Association
Gülşah Yıldırım	Department of Food Codex and Feed Legislation	Government of Turkey
Helena Pastell	Research Professor	Ruokavirasto (Finnish Food Authority)/ NMKL
John Collins	Technical support	IFU/UK
Juliana Azevedo Lima Pallone	School of Food Engineering - UNICAMP	Brazil
Katerina Mastovska	Deputy Executive Director & Chief Science Officer	AOAC/USA
Lise-Anne Prescott	Science and Research Coordination Team Lead CFIA	Canadian Food Inspection Agency / Government of Canada
Michael McCroan	Sr. Scientist	The Coca-Cola Company. USA
Mikko Hofsommer	CEO & MAC chair	GfL/IFU/Germany
Ross Simmons	Supervisory Chemist of AMS Science and Technology Program	USA

Ruth Ivory	Biochemistry Manager at Megazyme/Neogen	on behalf of AOAC
Sneh Bhandari	Independent Consultant (previously R&D Director at Merieux Nutrisciences)	on behalf of AOAC
Steve Cockram	General Manager (now retired)	Growers Co-Op Grape Juice Company – USA
Thomas Hektor	Director Research & Development, R-Biopharm AG	on behalf of AOAC
Vladimir Eliodoro Costa	Professor	Department of Biophysics and Pharmacology, Institute of Biosciences - Brazil

## 1) Definitions used in this document:

### i) Fruit Juice authenticity:

“**Fruit juice**” is a protected term, which is defined in the *General Standard for fruit juices and nectars* (CXS 247-2005) or relevant national legislation. A fruit juice, or its concentrate, should conform with the standard and be labelled correctly and not in a way to deceive the consumer by containing undeclared additives such as sugars, acids, colours or preservatives etc or a cheaper juice or fruit extract that does not conform with the definition of fruit juice e.g. a citrus comminute or cloudy concentrate.

A fruit juice, or its reconstituted concentrate, should show characterises that are similar to the sound ripe fruit from which it is derived, allowing for deviations due to the processing techniques employed during extraction and production. Juices from different fruits maybe blended,

provided the product is labelled appropriately with the blend composition.

### ii) Fruit Juice quality:

The composition of a fruit juice, or its reconstituted concentrate, should be representative of the sound and ripe fruit from which it is derived using the principles of GMP.

### iii) Food fraud (economic adulteration), as defined by the US FDA (2009)

*The fraudulent, intentional substitution or addition of a substance in a product for the purpose of increasing the apparent value of the product or reducing the cost of its production”.*

### iv) Abbreviations:

**HPLC** = high performance liquid chromatography

**Cap-GC** = Capillary gas chromatography

**IRMS** = isotope ratio mass spectroscopy

**CRDS** = cavity ring down spectroscopy (used for  $\delta^{13}\text{C}$  measurement instead of IRMS)

**D-NMR** = Deuterium Nuclear Magnetic Resonance spectroscopy on the ethanol formed from the sugars contained in the juice

**Oligosaccharide profiling** = Detection of unusual disaccharides not normally seen in fruit juices but detectable in sugar syrups

**HFCS** = high fructose corn syrup

**HFSS** = high fructose syrup from starch (from  $\text{C}_3$  based plant e.g. rice, cassava etc)

**HFSl** = high fructose syrup from inulin (a  $\text{C}_3$  plant which liberates a syrup rich in fructose)

## 2) Introduction

**It should be stressed that the majority of fruit juice producers/suppliers are legitimate businesses and produce authentic juices. When evidence is produced to show that there are unscrupulous suppliers active in the market it is not only the “cheaters” that are adversely affected.**

**Consumers can lose confidence in all juice products so all producers can suffer from unscrupulous actions. This is one reason why legitimate producers have worked with regulators, juice associations and laboratories to develop methods to force the “crooks” from the market. It should be mentioned, that so far, the unscrupulous suppliers have only used food grade materials, so their fraudulent actions have not posed a health risk to consumers. Nevertheless, their actions are food fraud and it is incumbent and beneficial to all legitimate suppliers to assist in stamping out these fraudulent producers.**

Detailed in this document is some background information which highlights the issues that have been seen with the extension of fruit juices over the years and the continued struggle that the industry and Governments face to block unscrupulous producers from the market who are misrepresenting their products as fruit juices when they contain an undeclared cheaper juice or additives (such as sugars, acids, colours or preservatives).

## **2.1 Objective**

Due to a lack of time the Expert group did NOT make any recommendations for the endorsement of new methods that should be considered by CCMAS. However, there are some that could be considered and these will be discussed when new work is initiated to revise Standard 247 and bring it up to date as it is now 20+ years old. These new methods will then be introduced, in due course, using the regular CCPFV/CCMAS approval process.

## **3) IFU working Group**

The objective of this IFU expert group was to examine and consider the methods presently endorsed within the CXS 247-2005& CXS 234-1999.

### **Aims:**

- i) The expert group will decide if, in their expert opinion, the existing methods should be retained within the Codex system.
- ii) Determine if the procedures endorsed are still “fit for purpose” to control the quality and authenticity of fruit juices.
- iii) The expert group will prepare a recommendation for consideration by the CCMAS endorsement WG and the plenary session of CCMAS45 in March 2026.

The IFU expert group was made up of juice experts taken from Government and private laboratories, juice associated companies, supply industries and relevant SDOs from around the world. The members are listed in section c of this report with their associated affiliations. The expert group had multiple virtual sessions, between September 2025 to February 2026, where the group accessed the methods listed in CXS 247 and CXS234. Copies of the methods were supplied by the relevant SDO and IFU thanks them for their cooperation with this work. It also thanks all the WG members for their assistance in carrying out this important work for the fruit juice industry.

Some notable examples of the adulteration issues that have been seen over the years are listed in section 9 of this report to provide background to readers of this issue, the methods that were employed to detect and limit these fraudulent activities are quoted.

## **4) Assessment procedure**

Copies of the methods were provided by the relevant SDO so that members of the WG could review and compare the procedures. Some background to the usefulness of the procedures and continued need was provided and the methods were then discussed by the group. It decided if they were still “fit for purpose” and whether they should be retained or transferred into of CXS 234. The group also examined the present listing in the standard, where more than one procedure is quoted, to ensure that the methods share the same technical details but are written in different manners to meet the SDO’s format.

ISO did not provide access to their procedures, even after reminders so no firm conclusion could be made about the procedures and their compatibility with other method/s that they may presently be listed with within CXS 247 & CXS 234. Therefore, the group could not recommend that these methods, presently listed in CXS 234 & CXS 247, are retained or transferred to CXS 234.

## **5) Outcomes**

The group agreed that there is an ongoing issue with the extension of fruit juices with cheaper materials, which when sold defrauds the consumer as the products are not correctly represented by their description. A few notable examples of these issues are illustrated in section 9 of this report. In the light of their experience the group is of the opinion it is critical to maintain a list of approved and validated methods within the Codex system

so that Governments and other interested parties have a list of procedures that they can use if it is suspected that there is an issue with adulterated juice products in their market. If no surveillance work has been carried out in their markets recently it might be worthwhile carrying out one as there are some issues in many markets, if there are on sale.

The group concluded that the majority (52) of the 56 methods assessed should be retained in or transferred to CXS 234. The group was happy that these procedures are still required and were appropriately validated to ensure acceptable results. These recommended methods are listed in Table 2 of this report. Also quoted in this table is the typical range of levels for the compounds that are seen in juices in general. However, as we are dealing with natural products and as different juices often contain different levels, the values presented cover a large range and do not provide much useful information for Governments. However, it was a request from CCMAS that these values were provided.

There are sources of data available to assist the evaluation of fruit juices, such as the AIJN (European fruit juice association) Code of Practice<sup>(1)</sup> and other published sources such as the SGF database of authentic commercial products. Data for this system are collected from SGF approved suppliers on a regular basis<sup>(2)</sup> from a range of sources in the world. Care needs to be taken when using papers published in the open literature, concerning the authenticity of any commercial samples taken from the retail trade and analysed, unless significant steps are taken to ensure their nature. Fruits pressed in the laboratory will give authentic data, however, how representative these are of commercial products might be an issue. For many parameters there will not be significantly different values between laboratory and commercially prepared samples. However, in some cases there can be differences for parameters that are affected by squeezing pressures. It should be remembered as these are natural products, extracted from fruit, that different varieties and or growing conditions may give rise to different values in the resultant juice. The use of delta <sup>18</sup>O values for the characterisation of not from concentrate juices is a particularly sensitive parameter that is strongly affected by differences in seasonal rainfall and unusual local climatic conditions.

From examination of the methods, it was clear that some of the procedures listed in CXS 247 & CXS 234 with a "/" are no longer based on the same method and so should not be listed as such. Although the principle of the method has not changed, different columns are used. This does not invalidate the procedures and we propose developing a new provision to be added to 234 with one method retaining its Type II status and the other listed as a Type III, as they are both based on HPLC. These cases are listed in Table 4. In another set of methods for sulfur dioxide, the AOAC, IFU and NMKL methods are all listed under the same provision. However, although the first two procedures are the same and should use the / notation the NMKL method uses a derivatisation step and uses a spectrometric method for quantification, rather than the titrimetric method used in the other two procedures. We would therefore suggest to CCMAS that the NMKL procedure should be listed as a separate provision and be made a Type III method, listed in Table 3.

## **6) Conclusions**

To fight these fraudulent actions in this product sector, it is critical to maintain a list of suitable procedures within the Codex standard method system, e.g. within CXS 234 that analysts can rely upon to control the quality and authenticity of fruit juices.

As most assessments of fruit juices are initially based on a multicomponent analysis of the product, looking for abnormal values for that juice from that country/region, the approaches used by the SDOs to validate the procedures are appropriate to assess their performance.

As compared with many foods the additive list for juices is relatively short and over half of these provisions are based on GMP so there is no numerical provisions for these compounds either. Therefore, the lack of a control values for the quality/authenticity provisions are not out of line with many of the additive provisions listed in the GFSA for these product groups (14.1.2.1 & 14.1.2.3).

### **6 a) Future work**

At present there is a problem with the methods based on enzymic procedures due to kit supply. For many of the procedures presently listed in CXS 247 using an enzymic based method there are alternatives based on HPLC. However, for two analytes in particular, D-malic and D-isocitric acids, there are no existing conventional HPLC methods approved that offer the same sensitivity and selectivity of the enzymic procedures. The methods covered are listed in Table 5

IFU is reviewing this situation at present but there was insufficient time between the two CCMAS meetings (2025/2026) to make a firm proposal for these procedures. We would thus ask permission from CCMAS to postpone the decision on all these enzymic procedures until the next CCMAS meeting in 2027.



## 7) Normal provisions within a Codex standard

With a normal Codex standard, numerical provisions are set down for important parameters to define either a quality parameter or a defining parameter for a particular food. When the fruit juice standard CXS 247 was being prepared by the ad hoc task force, only one numerical provision was inserted for each juice, that was the minimum Brix for a reconstituted juice concentrate. Defining this parameter for the 70+ juices listed in the standard took all four meetings of the task force before a consensus value could be agreed for each juice.

The issue of a required provision for a method did not arise until just before the last task force meeting (2004) there was no time to develop the 5000+provisions for the proposed methods that would be required. As we are dealing with a natural product, each component (compound) is likely to be present at different levels in the 70 or so juices covered by the standard, meaning that over 5000 new provisions would have had to be developed, which is not particularly constructive work for a committee. This would also provide an unscrupulous supplier with a “recipe to match” that could make taking legal action more difficult to prevent this type of fraud.

## 8) Driving force for the adulteration of fruit juices by unscrupulous producers

The extension of fruit juices, for unfair economic reasons (food fraud), has been an issue for many years, as mentioned below in section 9. This is very likely to continue while the price of fruit juice solids remains significantly higher than sugar (sucrose) and sugar syrups, which are typically used to extend fruit juices. Sugar and sugar syrups are typically around \$ 500 to 600 per tonne whereas fruit juice solids are typically \$1500 to 3000 and higher per tonne, which offers a significant incentive for an unscrupulous supplier to cheat.

It should also be remembered that most fruit juices typically only contain around 10 % sugar, at single strength, so by direct substitution of “fruit juice solids” with sugar, a tonne of sugar could make the equivalent of ca 10,000 litres of an adulterated juice. Normally the adulteration of a fruit juice product is rarely as bad as 100 %, but lower levels of extension are commonly used by an unscrupulous supplier. These unscrupulous suppliers intend to commit food fraud by mis-representing their products as legitimate fruit juices to make an illicit profit. Over the years legitimate producers, fruit juice associations, Governments and laboratories have spent a lot of time and money to develop methods that can be used to tackle this issue. Presently the Codex Committee on Food Import and Export Inspection and Certification Systems (CCFICS), is working on guidance for Governments as to how best tackle the issue of adulteration of food products, which will include fruit juices.

## 9) Notable examples of fruit juice adulterations in commercial products

This is not an exhaustive list of problems but does highlight some notable cases. In most cases a hyperlink is provided with some additional information about the incident for interested readers:

**a) Mid 1980's Beechnut Corporation:** in the US this company was selling adulterated apple juice. This adulteration was detected by the relative levels of sucrose, glucose and fructose, which were incorrect for apple juice and the carbon isotopic analysis showed the presence of cane/corn sugars by its high delta<sup>13</sup>C value.

[Beech-Nut accused of selling fake apple juice - UPI Archives](#)

[BEECH-NUT GUILTY IN JUICE FRAUD - The Washington Post](#)

[Beech-Nut Nutrition Corporation \(A-1\) - Case - Faculty & Research - Harvard Business School](#)

**b) 1991 UK MAFF study:** concluded 16 out of 21 brands of orange juice tested were adulterated with a range of substances which included sugars and acids. Here a range of different approaches were used to detect the problems including isotopic procedures, oligosaccharide profiling and organic acid analysis.

[Orange-juice wrangle gives ministry the pip: Acting as consumers' champion has backfired on civil servants | The Independent | The Independent](#)

**c) 1994 Sunup foods:** where “orange juices”, being manufactured for the US “schools food program”, were extended with sugar. A hidden syrup room had to be used in this process as the plant was under constant USDA inspection during juice production for this Government funded scheme. The FDA received a tip off from an employee to look for the syrup room behind a fake electrical panel in the factory.

[Company "stretched" orange juice too far; 3 convicted](#)

[RCED-96-18 Fruit Juice Adulteration: Detection Is Difficult, and Enhanced Efforts Would Be Costly](#)

**d) 1994 UK trader:** convicted of selling orange juice imported from Greece that would best be described as an “orange nectar” (e.g. it only contained ca 50 % juice). The adulteration was clearly identified by conventional methods (sugar, organic acid and mineral profiles) and later confirmed by an isotopic method (D-NMR)

### Author's personal information

**e) 1996 Apple juice concentrates:** on sale in Europe and US that contained undeclared high fructose syrups from hydrolysed inulin syrups (extracted from either Jerusalem artichoke and/or chicory). This was a novel extension approach as both of these plants use the C<sub>3</sub> pathway to fix carbon dioxide from the atmosphere and so these syrups do not carry the normal C<sub>4</sub> marker seen if a high fructose syrups derived from corn (HFCS), which was the conventional method of extension of apple juices. This approach made the extension much harder to detect. Here a Cap-GC fingerprinting method was employed looking for unusual oligosaccharides which are not found in authentic apple juices or other juices.

### Food news article 23<sup>rd</sup> February 1996 and author's work

**f) 2000's Misrepresentation of low acid apple juice as a high acid variety:** the sale of cheap, low acid, apple juice in Europe which had had its acid content "boosted" by the addition of synthetic L-malic acid, which made the product more desirable to purchase. This was a novel way to adulterate a juice, as in the past D,L-malic acid had been used. Use of the L-form made is harder to detect and an internal <sup>13</sup>C isotopic method had to be used for this detection together with analysis for fumaric acid by HPLC (a dehydration product of malic acid).

### Personal communication

**g) 2009 USA, Pom Wonderful:** took legal action against Purely juice who they contended was selling adulterated pomegranate juice containing undeclared materials including cane/corn sugars. The extension was detected using <sup>13</sup>C isotopic analysis and oligosaccharide profiling.

### [Purely Juice to Pay \\$1.5 Million as Settlement for False Advertising](#)

**h) 2012 US National Consumer Association:** identified a range of lemon juices, sold as a "condiment", which contained added undeclared citric acid. This adulteration was detected using <sup>13</sup>C isotopic and other conventional organic acid analysis.

### [Poster from 2016 AOAC annual conference](#)

**i) 2014 US importer ITT:** conducted a study on coconut waters on sale in the US that showed 12 of 20 samples contained undeclared added cane/corn derived sugars by <sup>13</sup>C isotopic analysis.

### [Coconut water: a fair target? | Analysis & Features | The Grocer](#)

**j) 2016 UK National crime agency:** the importation of 7 brands of coconut water coming from Thailand were blocked at the UK border. These products were incorrectly labelled as they contained undeclared added sugar, which was detected using <sup>13</sup>C isotopic analysis.

### [FSA probe finds widespread addition of undeclared sugar in coconut water | News | The Grocer](#)

**k) 2025 IFU warned members of ongoing issues with adulteration of fruit juices:** early last year IFU sent a letter to all its members to raise their awareness of issues of offers being made for adulterated juices on the market and suggested that they should enhance their testing regimes accordingly to mitigate this risk.

Issues in 2025 indicated that there were issues with a range of fruit juices. This included coconut water, where samples described as 100% clearly contained undeclared added cane/corn derived sugars. This was detected by an anomalous (high) delta <sup>13</sup>carbon isotope ratio and/or presence of markers for starch derived syrups, detected by the unusual oligosaccharides from either a C<sub>4</sub> (HFCS) or C<sub>3</sub> (HFSS) source.

**l) 2026 SGF & Hungarian Authorities detected adulterated orange juice on sale in the country.** The presence of significant levels (ca 30 %) of added cane/corn derived sugars/syrups were detected in commercial orange juice from one supplier in Hungary. The adulteration was detected as part of the routine quality assurance program in that market by SGF profiling© (<sup>1</sup>H-NMR). The presence of the added C<sub>4</sub> derived sugars was then confirmed by carbon isotopic analysis and Oligosaccharide profiling as discussed above in section e & in section 10 below.

These examples illustrate that this is still a continuing problem and emphasis the need to retain the procedures in the Codex system.

## 10) Approaches used to detect adulteration issues

As illustrated above, a wide range of methods have been used to identify and confirm when juices have been adulterated. The approach adopted has to remain flexible to detect the various approaches that an unscrupulous producer may use or develop in the future. Traditionally a range of different components of a

fruit juice are quantified using different methods (HPLC, enzyme linked assays, spectrophotometric, traditional wet chemical methods and fingerprinting procedures such as anthocyanin and oligosaccharide profiles) and these still remain valid today, as illustrated above. These approaches often provide the initial indication of an adulteration which may then be confirmed using more sophisticated procedures.

Most of the procedures used are listed in CXS 247 & CXS 234 under the provision for “quality and authenticity” assessment. These methods were developed and validated in interlaboratory studies by the following Standard Development Organisations (SDOs):

- i) Association of official analytical chemists (AOAC)
- ii) International fruit and vegetable juice association (IFU)
- iii) International standards organisation (ISO)
- iv) Nordic (Baltic) committee on food analysis (NMKL)

Using a range of these procedures allows the analyst to develop a range of data which gives a multicomponent screen (MCCA) of the product. These data are then critically examined by a juice expert, who compares the sample data with values for known authentic juices in their databases, or in databases such as those published by the European fruit Juice Association (AIJN) in their Code of practice<sup>(1)</sup>, country specific data held by SGF<sup>(2)</sup>, or other published sources.

Depending on the depth of screening used, sometimes these initial data may highlight where additional testing should be used to provide confirmatory analysis. These confirmatory tests often involve the use of isotopic methods which are expensive to deploy and require very specialist equipment and analysts but often provides conformation of adulteration.

A typical screening protocol is given in Appendix 1 for three basis types of juices red/black, acid rich and sugar rich juices, most fruit juices fit into this last category. The multicomponent approach has been updated in the last 10 years or so, by the use of <sup>1</sup>H-NMR spectroscopy as a profiling technique<sup>(7, 8)</sup>, which is now widely used in Europe and other areas. This allows much of the significant organic chemistry of a fruit juice to be determined in some 15 to 20 minutes and so offers a very cost-effective screening procedure. However, the traditional approach is still used and offers a worthwhile approach, although taking much longer to conduct, but requires far less sophisticated equipment, which will be available within a “normal” juice laboratory rather than a much more specialist centre. Sometimes the isotopic methods are used as part of the screen, depending on the laboratory setup.

Work in the 80 & 90’s showed the critical importance of using stable isotopic methods to detect economic adulteration. These methods allowed the source of the sugar to be identified and allowed exogenous sugars to be detected if added to a fruit or vegetable juice. This approach initially used carbon isotopic analysis (<sup>13</sup>C-IRMS) and more recently cavity ring down spectroscopy (<sup>13</sup>C-CRDS). It was found that cane and corn derived sugars showed very different levels of the two stable carbon isotopes (<sup>13</sup>C/<sup>12</sup>C) when compared to most fruit juices. This is because the cane and corn plants use the Hatch–Slack pathway (C<sub>4</sub> pathway) to fix carbon dioxide from the air, whereas most plants that produce fruits use the photosynthetic pathway (C<sub>3</sub> pathway). The former plants give delta <sup>13</sup>C values around -11 ‰ whereas this value in fruits is generally around -25 ‰. Pineapple and dragon fruits are two notable exceptions as these plants use a third method to fix their carbon dioxide from the atmosphere, the crassulacean acid metabolism (CAM), which gives delta <sup>13</sup>C values around -12.5 to -14.0 ‰.

All of these values are negative as the sugar and fruit juices contains less <sup>13</sup>C carbon isotope than the isotopic reference standard used in this method (a limestone, PDB). Here the limit of detection of added cane/corn sugars is around 10 %. However, various approaches have been employed to enhance the sensitivity of the methodology such, as using an internal isotopic marker like pulp or the values seen in two different sugars, or an acid, or using different stable isotopes within the same compound. These various procedures are reviewed in the IFU recommendation No 3<sup>(3)</sup>.

The routine introduction of the carbon isotopic procedures forced some of the unscrupulous suppliers to switch their adulteration strategy to extend their fraudulent products. Hence these producers moved over to using beet sugar or beet derived syrups as the extension medium rather than cane or corn-based sugars. This presented some problems for them, as this form of sugar was less accessible and could be more expensive in countries with hot climates, where cane/corn derived sugar/syrups may be produced. However, the use of beet derived sugars offered a lower risk of detection as they showed the same carbon isotopic values and made detection more difficult.

The use of beet rather than cane/corn sugars as a means of adulteration was suppressed by the introduction of the use of deuterium nuclear magnetic resonance spectroscopy (D-NMR), as developed by Eurofins<sup>(9)</sup>. This technique, in combination with <sup>13</sup>C-IRMS, allowed the detection of cane, corn and beet derived sugars to be detected in many juices. The routine use of this procedure limited the use of beet derived sugars and probably led to the use of other types of sugar syrups, (see Cap-GC below and section 9 e).

Although these two isotopic methods offer good approaches to detect the addition of sugars to juices, they both require the use of very expensive equipment and highly specialised scientists to run. This means they have a more limited availability in most countries, so samples have to be sent to a specialist centre and so these procedures are often only used as a confirmatory step. Although one or both of these isotopic methods may be used as part of an assessment of fruit juices, it is still common to use a multicomponent screening approach as most/all of these methods are available in a normally equipped analytical laboratory and much more expensive specialist equipment is required to undertake the isotopic procedures.

As many authenticity assessments are based on detecting deviations in the normal levels of the various components expected in a fruit juice, the validation procedures used by the SDOs, mentioned above, are appropriate and ensure that the procedures are “fit for purpose” for the assessment of the quality and authenticity of a juice and can be used safely, provided a representative database is used in their assessment.

Some of the multicomponent tests offer clear and definitive answers. For example, if a significant level of sorbitol is detected in that a juice type, which normally contains none or only traces, this would be very good evidence to indicate another sorbitol containing juice, had been added. This can be illustrated by a sample of “raspberry juice” which was found to contain a significant level of sorbitol which is unusual. In this case other components in this sample were examined and the pattern of anthocyanins was unusual and indicated the presence of cherry juice. Cherry is known to contain significant levels of sorbitol (ca 10 – 30 g/l). Similarly, if the mannitol level in pomegranate juice was found to be low and tartaric acid and unusual grape anthocyanins were present in the product, this would be a clear indication of an extension of the pomegranate juice with a red grape juice, which can still be seen in some samples today.

In the mid 90's a new capillary-GC method was introduced into Europe from Canada. This procedure was initially developed for the detection of invert syrups and high fructose corn syrups by Prof. Nick Low from the University of Saskatchewan. While working at Reading Scientific Services in the UK in 2005 it was found that the procedure could also identify if a hydrolysed syrup derived from inulin (HFIS) was being used to extend apple juices<sup>(4)</sup>. This was a clever form of adulteration as the syrups themselves were rich in fructose, which mimicked apple juice, but the plant sources, Jerusalem artichoke or chicory, were both C<sub>3</sub> plants and so the syrups did not carry the normal C<sub>4</sub> marker seen with high fructose corn syrups. This made them an ideal adulterant for apple juice. In this case an adulteration had been suspected with this product from the conventional MCCA approach, but no firm “proof” was available as this sophisticated adulteration was specifically intended to hide the fraudulent practice. The proof was obtained when two markers for the HFIS were detected using this procedure. This method is now routinely used in many screening procedures. The CAP-GC method was also found to offer a higher sensitivity to the presence of HFCS in clear apple juice than was possible using the standard <sup>13</sup>C isotopic procedures<sup>(3)</sup>.

## 11) References:

- 1) AIJN reference guides for the assessment of the quality and authenticity of fruit juices [AIJN code of practice](#) (free to members and subscribers)
- 2) SGF (safe global and fair) International organisation that provides services to regulate and approve suppliers of fruit juice to ensure fair trade. [Safe Global Fair](#)
- 3) IFU recommendation #3. Use of isotopic methods for the detection of juice adulteration (2020) (free to IFU members and Governmental control laboratories)
- 4) IFU recommendation #4. Detection of sugar syrups by Cap-GC analysis (2021) (free to IFU members and Governmental control laboratories)
- 5) Codex standard for fruit juices and nectars (247 (2005) [fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandards%252FCXS%2B247-2005%252FCXS\\_247e.pdf](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandards%252FCXS%2B247-2005%252FCXS_247e.pdf)
- 6) Codex standard of standard methods. [fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandards%252FCXS%2B234-1999%252FCXS\\_234e.pdf](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandards%252FCXS%2B234-1999%252FCXS_234e.pdf)
- 7) SGF/Bruker (2009). <sup>1</sup>H-NMR screening method for fruit juices. [NMR-Based Multi Parametric Quality Control of Fruit Juices: SGF Profiling](#)

- 8) IFU review of methodology #1, 2020. [Review of Methodology - International Fruit and Vegetable Juice Association](#) (free to IFU members and Governmental control laboratories)
- 9) Use of Deuterium NMR as a method to detect the presence of added sugars to wines and fruit juices. [The SNIF-NMR® Concept - Eurofins Scientific](#)

**Table 1: Recommendation to CCMAS for method delisting (revocation) in  
CXS 234 and/or CXS 247**

PROVISION	METHOD	PRINCIPLE	TYPE	Reason for removal
Vitamin C (Quality and Authenticity)	EN 14130 (removal from CXS 247)	HPLC-UV	II	No longer supported by CEN
Pectin (Additives and authenticity)	IFU Method No. 26 (Removal from CXS 247 and 234)	Precipitation /photometry	I	Lack of validation data
Stable hydrogen isotope ratio of water from fruit juices (Authenticity)	ENV 12142 (1997) (removal from CXS 247 and 234)	H/D IRMS	II	No longer supported by CEN
Carbon dioxide (Additives and/or Processing aid)	IFU Method No. 42 (1976) (removal from CXS 247)	Titrimetry (back-titration after precipitation)	IV	No longer supported by IFU

**Table 2: Recommendation to CCMAS for method re-endorsement and retention in or transferred to CXS 234**

PROVISION	METHOD	PRINCIPLE	TYPE	Juice Min (g/l)	Juice Max (g/l)	Condition
<b>Vitamin C (dehydro-ascorbic acid and ascorbic acid)</b> (Quality/Authenticity)	AOAC 967.22	Microfluorometry	III	0.02	0.5	unless declared as an additive
<b>Ascorbic acid-L</b> (Additives)	IFU Method No. 17a	HPLC-UV	II	0.02	0.5	unless declared as an additive
<b>Ascorbic acid-L</b> (Additives)	AOAC 967.21 /ISO 6557-2(?)	titrimetry (Indophenol method)	III	0.02	0.5	unless declared as an additive
<b>Ascorbic acid-L</b> (Additives)	IFU Method No. 17b	potentiometric titrimetry (iodine)	III	0.02	0.5	unless declared as an additive
<b>Determination of glucose, fructose, sucrose and sorbitol</b>	IFU Method No. 67 (1996)	HPLC-RI	II	S =traces, G = 3, F = 3	S = 110, G = 110, F = 110	unless declared as an additive
<b>Quinic, malic and citric acid in cranberry juice cocktail and apple juice</b> (Quality/Additive/Authenticity)	AOAC 986.13	HPLC-UV	III	Q = 5 CJ, C = 5 CJ, M = 5 CH, Q= traces AJ, C = 0.05 AJ, M= 2 AJ	Q = 15 CJ, C = 15 CJ, M = 10 CJ, Q= traces AJ, C =0.2 AJ, M= 8 AJ	Unless declared as an additive
<b>Sucrose</b> (Additive/Authenticity)	IFU Method No. 67 <del>NMLKL 148</del> <del>EN 12146</del>	HPLC-RI	II	1 (II?)	110	unless declared as an additive
<b>Tartaric acid in grape juice</b> (Quality/Additive/Authenticity)	IFU Method No. 65	HPLC-UV	II	nd except grape = 1	7 in grape	unless declared as an additive
<b>Fermentability</b> (Quality/Authenticity)	IFU Method No. 18	Microbiological method	I		positive or negative	Grandfather the method
<b>Anthocyanins</b> (Quality/Authenticity)	IFU Method No. 71	HPLC-UV	I	No minimum	Nor maximum	pattern is critical
<b>Beet sugar in fruit juices</b> (Authenticity)	AOAC 995.17	Magnetic Resonance spectrometry (D-NMR)	II	Depends on juice	Depends on juice type	provided no sugars added
<b>C<sup>13</sup>/C<sup>12</sup> ratio of ethanol derived from fruit juices</b> (Authenticity)	JAOAC 79, No. 1, 1996, 62-72	IRMS	II	-11 permil	-28 permil	juice dependant & provided no added C <sub>4</sub> sugars
<b>Carbon stable isotope ratio of apple juice</b> (Authenticity)	AOAC 981.09 - JAOAC 64, 85 (1981)	IRMS	II	-23 permil	-26 permil	juice dependant & provided no C <sub>4</sub> sugars added
<b>Carbon stable isotope ratio of orange juice</b> (Authenticity)	AOAC 982.21	IRMS	II	-23 permil	-26 permil	juice dependant & provided no C <sub>4</sub> sugars added
<b>Carotenoid, total/individual groups</b> (Authenticity)	IFU Method No. 59	Spectrophotometry	I	0.05	0.3	

<b>Cellobiose</b> (Quality/Authenticity)	IFU Recommendation No. 4 October 2000	Cap-GC-FID	IV	nd < 0.01	20<	xs use of cellulases
<b>Formol number</b> (Quality/Authenticity)	IFU Method No. 30	Potentiometric titration	I	0.7	60	
<b>Free amino acids</b> (Quality/Authenticity)	IFU Method No. 57	Liquid Chromatography	II	variable	variable	
<b>Hesperidin and naringin</b> (Quality/Authenticity)	IFU Method No. 58	HPLC	II	250	750	Pulpwash detection
<b>High Fructose Corn Syrup and Hydrolysed Inulin Syrup in apple juice</b> (Additive/Authenticity)	JAOAC 84, 486 (2001)/IFU rec 04	CAP-GC-FID	IV		< 0.025	provided no added sugar syrups
<b>Naringin and neohesperidin in orange juice</b> (Quality/Authenticity)	AOAC 999.05	HPLC-UV	III		Nar < 1.2, neohes	
<b>Phosphorus/phosphate</b> (Quality/Additive/Authenticity)	IFU Method No. 50	Photometry	II	0.04	0.36	Provided no declared phosphate added
<b>Proline by photometry – non- specific determination</b> (Quality/Authenticity)	IFU Method No. 49	Photometry	I	traces	2.1	
<b>Sodium, potassium, calcium, magnesium in fruit juices</b> (Quality/Authenticity)	IFU Method No. 33	AAS	II	Na = nd, K = 0.8, Mg = 0.02, Ca = 0.005	Na = 1.0, K = 4.60, Mg = 0.35, Ca = 0.55	
<b>Stable carbon isotope ratio in the pulp of fruit juices</b> (Authenticity)	Analytica Chimica Acta 340 1997/IFU 88	IRMS	II	-23.5 permil	-28.5 permil	
<b>Stable carbon isotope ratio of sugars from fruit juices</b> (Authenticity)	Analytica Chimica Acta 271 (1993)/ IFU 88	IRMS	II	-11.0 permil	-27.0 permil	Provided no declared cane/corn sugars added
<b>Stable oxygen isotope ratio in fruit juice water</b> (Authenticity)	IFU 89	IRMS	II	-8.0 permil	+ 11.0 permil	Only applicable to NFC juices & concentrates
<b>Sugar beet derived syrups in frozen concentrated orange juice <math>\delta^{18}\text{O}</math> measurements in water</b> (Authenticity)	AOAC 992.09	IRMS	I	+3 permil	+ 11.0 permil	Only applicable to OJ concentrate
<b>Benzoic acid as a marker in orange juice for pulpwash</b> (Quality/Authenticity)	AOAC 994.11	HPLC	III			Only detected in OJ if used as a marker for pulpwash or additive
<b>Chloride (expressed as sodium chloride)</b> (Authenticity)	IFU Method No. 37	Electrochemical titrimetry	III	traces	4.28	
<b>Fumaric acid</b> (Quality/Authenticity)	IFU Method No. 72	HPLC	II	0.001	<0.02	Levels above 20 ppm should be examined closely
<b>Essential oils (Scott titration)</b> (Quality/Authenticity)	AOAC 968.20/ IFU Method No. 45	Distillation/titration	I	0.003	< 0.03	
<b>pH-value</b> (Quality)	IFU Method No. 11/ <b>NMKL 174</b>	Potentiometry	II	pH min 2.4	pH = 6.0	
<b>Soluble solids</b> (Quality)	AOAC 983.17/IFU Method No. 8	Indirect by refractometry	I	0	72	

<b>Starch</b> (Quality)	AOAC 925.38/ IFU Method No. 73	Colorimetric	I		presences/ absence test	grandfather the method
<b>Titrateable acids, total</b> (Quality/Authenticity)	IFU Method No. 3	Titrimetry	I	0.3 (as ACA)	90.0 (as ACA)	
<b>Benzoic acid and its salts; sorbic acid and its salts</b> (Additive)	IFU Method No. 63/ NMKL 124	HPLC-UV	II	nd	0.2 CJ	unless declared as an additive
<b>Ash in fruit products</b> (Quality/Authenticity)	AOAC 940.26/ IFU Method No. 9	Gravimetry	I	1	10	Provided no minerals added
<b>Sulfur dioxide</b> (Additive)	Optimized Monier Williams AOAC 990.28/ IFU Method No. 7A/ <del>NMKL 132 (to verify)</del>	Titrimetry (after distillation)	II		< 0.01	Use as an additive

Text in **red** is a proposed change of provision see Table 4

Text in **green** is a proposed change of provision see table 3

ACA = anhydrous citric acid



**Table 3: List of provisions that should be split in CXS 234****Revised/new provision required as methods no longer share the same column**

PROVISION	METHOD	PRINCIPLE	TYPE	Juice Min (g/l)	Juice Max (g/l)	Condition
<b>Sucrose</b> (Additive/authenticity)	IFU Method No. 67	HPLC-RI	II	Traces	110	Additive
PROVISION	METHOD	PRINCIPLE	TYPE	Juice Min (g/l)	Juice Max (g/l)	Condition
<b>Sucrose</b> (Additive/authenticity)	NMKL 148	HPLC-RI	III	Traces	110	Additive

**New provision suggested as a new compound has been added that can be determined using the IFU method, also NMKL uses a different column type**

PROVISION	METHOD	PRINCIPLE	TYPE	Juice Min (g/l)	Juice Max (g/l)	Condition
<b>Glucose, fructose, sucrose and sorbitol</b> (additive/authenticity)	IFU Method No. 67 <del>NMKL 148 (1993)</del>	HPLC-RI	II	S =traces, G = 3, F = 3	S = 110, G = 110, F = 110	Additive

Text in **red** is a proposed change of provision **Green** new provision added due to column

**New provision suggested as the NMKL method uses a different method of quantification to the AOAC and IFU procedures**

PROVISION	METHOD	PRINCIPLE	TYPE	Juice Min (g/l)	Juice Max (g/l)	Condition
<b>Sulfur dioxide</b> (Additive)	NMKL 132	Spectrophotometric (after distillation)	III		< 0.01	Additive

**Table 4: Two provisions that should be linked with a / in CXS 234**

PROVISION	METHOD	PRINCIPLE	TYPE	Juice min.	Juice max.
pH value (Quality and Authenticity)	NMKL 174/IFU 11	Potentiometry	II	pH = 2.4	pH = 6.0

**Table 5: List of enzymatic provisions that should be reconsidered in 2027 by CCMAS**

PROVISION	METHOD	PRINCIPLE	TYPE	Juice Min (g/l)	Juice Max (g/l)	condition
<b>Malic acid</b> (Additive)	AOAC 993.05	HPLC & Enzymatic determination	III	0.2	15	Unless declared as an additive
<b>Malic acid-D</b>	IFU Method No. 64	Enzymatic determination	II		< 0.01	unless declared as an additive
<b>Citric acid</b> (Additives/ Authenticity )	IFU Method No. 22	Enzymatic determination	III	0.05	75	unless declared as an additive
<b>Glucose-D and fructose-D</b> (Additive/Authenticity)	IFU Method No. 55	Enzymatic determination	II	G = 3 F = 3	G = 110 F = 110	unless declared as an additive
<b>Malic acid-L</b> (Additive/Authenticity)	IFU Method No. 21	Enzymatic determination	II	0.2	10	unless declared as an additive
<b>Sucrose</b> (Additive/Authenticity)	IFU Method No. 56	Enzymatic determination	III	1	110	unless declared as an additive
<b>Isocitric acid-D</b> (Quality Criteria/Authenticity)	IFU Method No. 54	Enzymatic determination	II	traces	10	
<b>L-malic/total malic acid ratio in apple juice</b> (Quality/Authenticity)	AOAC 993.05	Enzymatic determination and HPLC	II		Ratio ≤ 1.05	unless malic is declared as an additive
<b>Sorbitol-D</b> (Quality/Authenticity)	IFU Method No. 62	Enzymatic determination	II	traces	25	
<b>Acetic acid</b> (Quality/Authenticity)	IFU Method No. 66	Enzymatic determination	II	0.01	0.5	
<b>Alcohol (ethanol)</b> (Quality)	IFU Method No. 52	Enzymatic determination	II	traces	3	
<b>Gluconic acid</b> (Quality)	IFU Method No. 76	Enzymatic determination	II	0.01	< 1.3	
<b>Glycerol</b> (Quality)	IFU Method No. 77	Enzymatic determination	II	0.01	<1.3	
<b>Lactic acid- D and L</b> (Quality)	IFU Method No. 53	Enzymatic determination	II	0.2	0.5	
<b>Sulphur dioxide</b> (Additives)	NMKL 135	Enzymatic determination	III		< 0.01	unless declared as an additive

## Appendix 1: Proposed schematic for the assessment of fruit juice samples

