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Background Briefing ¹

Pyroligneous Acid ("Wood Vinegar") - Properties and Regulatory Standards

This note provides background information on Pyroligneous Acid (PA), particularly in relation to the properties and regulatory standards relevant to agricultural applications.

The benefits of Pyroligneous Acid ("Wood Vinegar") have been appearing in academic literature for decades, especially in Asia, where wood vinegar farming practices have existed for centuries.

In Australia, Northside Industries has been developing the market for four years with favourable responses across Australia, including broad acre farmers, orchards, nuts, vegetables, sugar cane, vineyards, hydroponics, and stock feed supplements. Benefits include soil enhancements, seed germination, plant health, crop yields, feed conversion and product quality (eggs, meat). PA often provides an adjuvant function, improving the efficiency of agricultural inputs. It is a natural product that can substitute for agricultural chemicals or reduce the amounts required. PA is widely recognised as a food quality ingredient. It will make an important contribution to sustainable agricultural practices.

Since there is no Australian standard for Pyroligneous Acid, this note presents our proposed Specification for Pyroligneous Acid as an active constituent in agriculture and food products, based on a consolidated analysis of recognised international standards and regulations.

a. Pyroligneous Acid is a recognised chemical substance

CAS Number	8030-97-5
FEMA Number	2967
EINECS Number	232-450-0
HS Code	2915.50.5000
FDA-21-CFR	172.515

PA is a natural substance, which contains many ingredients, mostly at trace levels, which contribute to its properties and beneficial uses (like wine), but is classed correctly as a single

¹ Updated September 2016, Northside Industries

chemical substance. It is widely used globally in the food industry as a smoke flavouring ingredient. It also has beneficial uses in agriculture, with a long application history throughout Asia.

b. Pyroligneous Acid has many common names

Pyroligneous Acid is the scientific name of the chemical substance. It is also commonly referred to as wood vinegar, smoke condensate, smoke water, bamboo vinegar and other names reflecting its manufacture as a water based by-product of char-making from biomass.

The variety of terminology can be somewhat confusing. For example, in USA and European regulations there is no differentiation between Pyroligneous Acid and smoke flavouring, whereas the WHO regulations differentiate between them. In the latter case, the difference is that the insoluble tars must have been removed to meet food flavouring requirements. This difference is not material to our own case, where we consider Pyroligneous Acid to be the refined product where insoluble oils and tars have been removed.

c. Pyroligneous Acid is a recognised food quality ingredient

- **WHO:** Pyroligneous Acid has been evaluated and approved by the FAO/WHO expert committee on food additives (JECFA)^{2, 3}
- **FEMA:** Pyroligneous Acid has been on the FEMA GRAS list for some sixty years⁴
- **FDA:** The US Food and Drug Administration lists Pyroligneous Acid as a food additive permitted for human consumption⁵
- **Japan:** Pyroligneous Acid is covered by the Ministry of Health and Welfare's specifications for food additives⁶
- **Health Canada:** Pyroligneous Acid and wood vinegar are approved food flavouring substances⁷
- **EC:** Regulations have been established to provide definitions and guidelines for the human consumption of Pyroligneous Acid⁸
- **Industry:** Pyroligneous Acid is included in the industry's widely referenced Handbook of Flavour Ingredients⁹

It is important to note the the **Australia New Zealand Food Standards Code** recognises substances approved under at least one of the above FEMA, FDA and Council of Europe

² Reference: World Health Organisation, (Joint Expert Committee on Food Additives)

<http://www.fao.org/food/foodsafetyquality/scientific-advice/jecfa/jecfa-additives/detail/en/c/421/>

³ Note that the Food Chemical Codex (FCC) of the US Pharmacopeial Convention recognises substances approved by FAO/WHO.

⁴ Reference: Flavour Extract Manufacturers Association

[http://www.femaflavor.org/sites/default/files/3.%20GRAS%20Substances\(2001-3124\).pdf](http://www.femaflavor.org/sites/default/files/3.%20GRAS%20Substances(2001-3124).pdf):

⁵ Reference: US FDA permitted to be added to food for human consumption

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=172.515>

⁶ Reference: Specifications and Standards for Food Additives, 8th Edition (2007), Ministry of Health and Welfare (Japan); Existing Food Additives Table FA04 page 161

⁷ Reference: Canada Health approved substance for food and medicinal:

<http://webprod.hcsc.gc.ca/nhpiddipsn/ingredReq.do?id=3178&lang=eng>

⁸ European Parliament and Council of European Union Regulation (EC) 2065/2003 on smoke flavourings used or intended for use in or on food; <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32003R2065> ⁹ Reference: Fenaroli's

Handbook of Flavour Ingredients, George Burdock, 5th Edition (year)

https://books.google.com.au/books?id=15HMBQAAQBAJ&pg=PA1656&lpg=PA1656&dq=jecfa+%2B+pyroligneous+acid&source=bl&ots=avYk8QMS-t&sig=K83mzC2GzlemBUyVtUVJrZkX_Vc&hl=en&sa=X&ved=0ahUKEwjY0b6B9MnMAhUI6KYKHeR_C8IQ6AEIjAB#v=onepage&q=jecfa%20%2B%20pyroligneous%20acid&f=false

listings with respect to food flavourings⁹ and substances approved under at least one of the Japanese, FAO/WHO, EC, FDA listings with respect to identity and purity¹⁰.

d. Pyroligneous Acid is generally regarded as safe

Recognition, evaluation and approval of substances as food ingredients by regulatory bodies clearly implies they are safe for human consumption, and by extension for animals.

Moreover, Pyroligneous Acid is explicitly included in the following GRAS lists:

- FEMA GRAS ⁴
- New Zealand GRAS register for Oral Nutritional Compounds ¹¹
- US FDA permitted to be added to food for human consumption

In the Australian context, it is important to note that the APVMA recognises NZ GRAS in its new stock feed regulations for suitable ingredients ¹².

Pyroligneous Acid is not listed in the following data bases regulating chemicals that can effect human health and environmental safety: Therapeutic Goods Administration (SUSMP6 Poisons Standard 2016), OCS, National Occupational Health and Safety Commission, or the National Pollution Inventory.

The Department of Health National Industrial Chemicals Notification and Assessment (NICNAS), lists Pyroligneous Acid as a substance where no notification conditions apply ¹³.

e. The Production Method

Pyroligneous Acid is a natural substance containing a complex array of trace ingredients, which reflects the variety of biomass feedstocks and processing equipment. In consequence, it cannot simply be defined by a chemical formula. In all jurisdictions, the definition of Pyroligneous Acid includes a fundamental statement of how it is made. For example:

“Smoke condensates are products obtained by controlled thermal degradation of wood in a limited supply of oxygen (pyrolysis), subsequent condensation of the resulting smoke vapours, and fractionation of the resulting liquid products (WHO, 2009 ²)”

f. Composition

Pyroligneous Acid is a water-based condensate. The acidity comes from natural occurring organic acids, of which the major component is acetic acid (up to 20%). The other main ingredients are carbonyls and phenolics, typically at lower concentrations than the acids.

⁹ Reference: Australian New Zealand Food Standards Code 1.1.2 "Permitted Flavour Substances"

<https://www.legislation.gov.au/Details/F2016C00478>

¹⁰ Reference: Australian New Zealand Food Standards Code 1.3.4 "Purity" (now superseded)

<https://www.legislation.gov.au/Details/F2014C01187d>

¹¹ Reference NZ Ministry of primary Industries, GRAS Register for Oral Compounds

http://www.foodsafety.govt.nz/registers-lists/gras/onc.htm?submit_search=Search&setup_file=acvm-gras-onc.setup.cgi&session_file=&sort_by=1&rows_to_return=1000&SUBSTANCE=pyroligneous+acid&ID=&TYPE=&FDC=&CI=&E=&FEMA=&EC=&submit_search=Search

¹² APVMA new stock feed regulations approved ingredients

<http://apvma.gov.au/node/13021>

¹³ Australian Department of Health AICS chemical database

https://www.nicnas.gov.au/search?query=pyroligneous+acid&collection=nicnas-meta&profile=_default

g. Refinement

The 'crude' pyrolysis condensate requires separation of any residual oil and tar fractions (top and bottom layers), suspended solids and other water insoluble particles, in order to make a Pyroligneous Acid product with suitable quality.

Various refinement processes are used in practice to achieve the required separation, including settling (most common), filtering, mechanical (eg centrifuge) and secondary distillation.

Refinement by such methods gives the Pyroligneous Acid its clarity. This can be measured by the refractive index of the PA, or alternatively by its turbidity.

A refractive index less than 1.4 has been adopted commercially to specify clarity ¹⁴. Turbidity less than 20 mg/L is considered an appropriate reflection of clarity and purity ¹⁵.

Moreover, separation of residual tars removes the risk of PAH's in the product. BAP is one of several PAHs that may occur in pyrolysis condensate; its quantification is used as a prime indicator for levels of PAH in Pyroligneous Acid.

Refinement of Pyroligneous Acid with respect to heavy metals to safe levels is normally controlled by using uncontaminated feedstocks.

h. Properties

The pH of Pyroligneous Acid is generally in the range 2-3.5, in line with other organic vinegars (hence the common names 'wood vinegar', 'bamboo vinegar' etc). Pyroligneous Acid has a smoky, burnt wood odour.

Its colour depends on age and feed material in the brown-red-yellow range. The clarity of the refined Pyroligneous Acid is manifest in reported values of Refractive Index in the range 1.33 - 1.4 (for reference clear water has an RI of 1.33).

Pyroligneous Acid is water soluble (with water insoluble substances removed in the refinement step).

i. Specification

The Australian Food Code sets minimum standards for food products in general. Although Pyroligneous Acid is permitted as a food ingredient, no specification is provided. The USA FDA uses the FEMA GRAS program as a basis of regulatory approvals. The FEMA Expert Scientific Panel has evaluated and approved Pyroligneous Acid for use in human food, but without a specification being provided. There are a variety of international programs that evaluate food substances, such as the European Food Safety Authority and the Joint FAO/WHO Expert Committee on Food Additives, which do specify standards that apply to Pyroligneous Acid. In addition, a number of Pyroligneous Acid manufacturers provide specifications for their products.

¹⁴ Sigma-Aldrich commercial product
http://www.sigmaaldrich.com/Graphics/COFAInfo/SigmaSAPQM/SPEC/W2/W296708/W296708-BULKK_ALDRICH.pdf

¹⁵ See <http://www.fondriest.com/environmental-measurements/parameters/water-quality/turbidity-total-suspended-solids/waterclarity/>; note that in most situations, water with turbidity < 20 mg/L appears clear, whereas above 40 mg/L it appears cloudy.

PyroAg is produced and refined to a set of minimum standards for Pyroligneous Acid, as an active constituent in agriculture, based on a consolidation of available regulatory requirements and industrial specifications. The proposed standard, shown covers:

- (1) the method of production and refinement
- (2) composition and
- (3) purity

Specification for Pyroligneous Acid as an Active Constituent in Agriculture

Functions	Requirements	Measures	Notes
Production and Refinement	Collection of the waterbased condensate from controlled and effective thermal decomposition of biomass	Temperature: 200-800°C	WHO Specification Upper limit minimises dioxins
	Effective removal of water insoluble tars, oils and solids from the condensate, manifest as clarity	Refractive Index < 1.4 Turbidity < 20 mg/L	Commercial specifications
Composition	Acetic Acid	2-20%	WHO Specification
	Phenols	0.1-16%	WHO specification
Purity	Metals (mg/kg)	Pb < 2 As < 1 Cd < 1 Hg < 1	Australian Food Minimum purity standards Pb limit matches WHO specification
	PAH as BaP (mg/kg)	< 0.01	European food standard

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