

Survey of Selected Samples of Tattoo Inks for the Presence of Heavy Metals

2013

Disclaimer

The analyses of samples and data in this report have been supplied to the Ministry of Health by the Institute of Environmental Science and Research Limited (ESR). The Ministry of Health cannot confirm the accuracy of the analyses and data provided and accepts no liability or responsibility for any acts or omissions, done or omitted in reliance, in whole or in part, on the data or the analyses.

Citation: Ministry of Health. 2013. *Survey of Selected Samples of Tattoo Inks for the Presence of Heavy Metals*. Wellington: Ministry of Health.

Published in July 2013
by the
Ministry of Health
PO Box 5013, Wellington 6145, New Zealand

ISBN: 978-0-478-40289-6 (online)
HP 5684

This document is available at www.health.govt.nz



MANATŪ HAUORA



This work is licensed under the Creative Commons Attribution 4.0 International licence. In essence, you are free to: share ie, copy and redistribute the material in any medium or format; adapt ie, remix, transform and build upon the material. You must give appropriate credit, provide a link to the licence and indicate if changes were made.

Contents

1	Background	1
2	Aim	3
3	Method	4
3.1	Sample selection	4
3.2	Scope and limitations	4
3.3	Analysis of tattoo inks	5
4	Results and discussion	6
5	Conclusion	11
6	Recommendation	12
Appendices		
	Appendix 1: Number of samples and brands collected from each website	13
	Appendix 2: List of colours sampled	14
	Appendix 3: Concentrations of heavy metal present	15

List of Tables

Table 1:	Maximum concentrations of heavy metals in tattoo and permanent make-up substances given in the EPA's <i>Guidelines for Tattoo and Permanent Make-up Substances (2012)</i>	1
Table 2:	Comparison of results with maximum permitted concentrations in the Guidelines	6
Table 3:	Number of non-compliant metals by colour shades* exceeding the EPA guidelines	7
Table 4:	Non-compliant metals by product brand	9

List of Figures

Figure 1:	Number of non-compliant metals by colour shades	7
Figure 2:	Number of non-compliant metals by product brand	10

1 Background

In November 2011, the Environmental Protection Authority (EPA) approved a new standard, the *Tattoo and Permanent Make-up Substances Group Standard*,¹ to better manage the risks associated with chemical composition of tattoo inks and permanent make-up substances. A tattoo substance is defined in the Group Standard as any substance or preparation intended to be injected into the human skin with a view exclusively or mainly to impart a skin marking or design.

In March 2012, the EPA released the *Guidelines for Tattoo and Permanent Make-up Substances (2012)*.² The Guidelines summarise the key responsibilities of importers and manufacturers of tattoo inks under the standard. They also contain a set of tables, which:

- list substances that tattoo inks and permanent make-up substances should not contain (including aromatic amines and various colouring agents); and
- specify the recommended maximum concentrations of certain heavy metals and polycyclic aromatic hydrocarbons in tattoo inks and permanent make-up substances.

While the Guidelines are not mandatory, they represent best practice guidance from the Council of Europe and the EPA recommends that they be followed to help prevent adverse effects from the application of tattoo inks.

For heavy metals, the guidelines recommend that tattoo inks should not have levels of heavy metals above the concentrations set out in Table 1.

Table 1: Maximum concentrations of heavy metals in tattoo and permanent make-up substances given in the EPA's *Guidelines for Tattoo and Permanent Make-up Substances (2012)*

Element or compound	ppm
Arsenic (As)	2
Barium (Ba)	50
Cadmium (Cd)	0.2
Cobalt (Co)	25
Chromium (Cr) (VI)	0.2
Copper (Cu) soluble	25
Mercury (Hg)	0.2
Nickel (Ni)	As low as technically achievable
Lead (Pb)	2
Selenium (Se)	2
Antimony (Sb)	2
Tin (Sn)	50
Zinc (Zn)	50

¹ Available at: www.epa.govt.nz/publications-resources/topics/Pages/Tattoo-inks-and-permanent-make-up.aspx

² Available at: www.epa.govt.nz/Publications/Tattoo-permanentmake-upguidelines.pdf

The Ministry of Health is an enforcement agency under section 97 of the Hazardous Substances and New Organisms Act, which states that ‘the Chief Executive of the Ministry of Health shall ensure that the provisions of this Act are enforced where it is necessary to protect public health’.

Tattooing practice is adopted worldwide and represents an important socio-cultural phenomenon, but, the injection into the skin of colouring agents such as metals might pose a risk of allergies and other skin inflammations as well as systemic diseases.³ In New Zealand, 20 percent of the population have a tattoo, including one in three people under the age of 30.⁴ A joint report by the World Health Organization and the University of Regensburg⁵ relating to risks and health effects for tattoos, body piercing and related practices indicated that non-infectious adverse reactions of tattoo inks have been published in the literature, which include hypersensitivity reactions to tattoo pigments for example, irritant and allergic contact dermatitis.

During 2012, the Ministry of Health carried out a survey of the levels of heavy metals in a sample of selected tattoo inks. Metals are used in tattoo inks because of their properties as colour pigments. Only those metals listed in the Guidelines have been analysed. Heavy metals are known to be toxic and may likely pose a risk to public health when used in tattoo inks. This report sets out the findings from this survey.

³ Forte et al. 2009. Markey survey on toxic metals contained in tattoo inks. *Science of the Total Environment* 407(23): 5997–6002.

⁴ ERMA New Zealand. March 2011. *Information sheet on the proposed Tattoo Inks Group Standard*.

⁵ www.gesundheit-nds.de/downloads/risksandhealth.pdf

2 Aim

The aim of the survey is to assess whether the tattoo inks supplied by identified, easily accessible, common or commercially established brands of tattoo ink suppliers (listed in Appendix 1) comply with maximum concentrations of heavy metals in the EPA's guidelines.

3 Method

3.1 Sample selection

A sample of 169 inks was purchased from 10 manufacturers' or larger international suppliers' websites (listed in Appendix 1). There were 18 brands sampled which consisted of 118 colour-variants. For all brands, one sample was purchased for each colour-variant⁶ and analysed except for the following brands: Tattoo Colour King (2 samples for each colour-variant); Silverback ink (grey wash series (4), silver back white (2); and grey wash series fresh (2); Mom's Millennium Colourworks (piss yellow (3), blue balls (2)); Intenze (bright red (2), lemon yellow (2), true black (2)). Brands and colour-variants are listed in Appendix 2. Inks were selected from across a range of established brands that are commercially available on the market (usually via the internet direct from the manufacturer's or suppliers' websites). Some brands also have New Zealand-based suppliers.

In selecting the brands of tattoo ink for analysis, and the colour-variants to be tested within each brand, the Ministry sought input from the newly formed New Zealand Tattoo Association. The Association comprises a small group of Auckland tattooists. The Association does not hold itself up as representing the views of New Zealand tattooists or the wider tattoo industry.

The survey is intended to provide a snapshot of some easily available, common or commercially established brands of tattoo inks sourced from suppliers named in this survey and therefore, the survey has a very limited scope (see 3.2 Scope and limitations).

Information was collected on the location of the suppliers' website, along with the cost, product brand, batch number and colour-variant of the product that was sampled.

The Ministry did not advise the suppliers it was purchasing the inks or the purpose for which the inks were being purchased (ie, to be tested for their heavy metal concentrations).

3.2 Scope and limitations

The focus of the survey was restricted to analysing the selected tattoo inks for the 13 heavy metals listed in the Guidelines – the survey did not test for other compounds that may be present in or added to the inks.

The survey did not look at how the inks are manufactured or any tattooing practices or procedures. In addition:

- it was not feasible to sample all brands of tattoo inks, nor all of the colour-variants of inks, on the market in New Zealand
- only pre-made inks sold in liquid form were tested (ie, no pigments that need to be mixed with another substance were tested)

⁶ Description for a specific variant of colour, eg, gamma green, Tahitian teal, spring green are all colour-variants of 'greens'.

- inks were predominantly sourced directly from overseas manufacturers or suppliers and not from New Zealand intermediaries
- inks manufactured or mixed within New Zealand were not tested
- substances that may be used for tattooing but are not sold as tattoo inks (eg, printer inks) were not tested
- the survey only assessed compliance with the guidelines and did not assess health risk.

3.3 Analysis of tattoo inks

Samples were analysed for arsenic, barium, cadmium, cobalt, chromium (VI), copper soluble, mercury, nickel, lead, selenium, antimony, tin and zinc by the Eurofins Environmental Laboratory Services (ELS). The bulk of heavy metals were analysed by microwave digestion in acid, followed by dilution and multi-element analysis on Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS). Buffered (pH5.5) aqueous extraction, dilution and ICP-MS analysis were employed in determining the soluble copper concentration. The Institute of Environmental Science and Research Ltd (ESR) analysed chromium (VI) using a modified version of the US EPA Method 218.7 by ion chromatography with post-column derivatisation and UV-visible spectroscopic detection.

4 Results and discussion

There were 169 inks from 18 brands purchased from 10 websites (listed in Appendix 1). Intenze and Kuro Sumi brands of inks were each purchased from two websites, www.unimaxwest.com and www.yuelongtattoo.com, and www.tattoosupply.co.nz and www.yuelongtattoo.com respectively.

The results of analysis were compared with the maximum permitted concentrations in the Guidelines (see Table 2). Detailed results are shown in Appendix 3.

According to the Guidelines, nickel levels in tattoo inks must be ‘as low as technically achievable’ because nickel has a high allergenic potential. However, this level cannot be assessed at this stage due to lack of knowledge of what is the lowest nickel concentration that can be introduced following good manufacturing practice. Therefore no comment can be made on whether this requirement has been achieved. Due to lack of this vital information, the analytical results were only presented without making any comment about compliance with the Guidelines.

Although the requirement in the Guidelines is for soluble copper, all of the 169 samples were analysed for the presence of total copper. Of the 169 samples, 64 samples exceeded the guideline for soluble copper (25 mg/kg). As a result, only these 64 samples were tested for soluble copper, of which 21 exceeded the Guidelines. The highest soluble copper level recorded was 32,900 mg/kg.

Table 2: Comparison of results with maximum permitted concentrations in the Guidelines

Metal	Co	Se	Cr(VI)	Sb	As	Ba	Cd	Pb	Hg	Sn	Zn	Cu soluble	Ni
EPA Guidelines mg/kg	25	2	0.2	2	2	50	0.2	2	0.2	50	50	25	As low as technically achievable*
No. of compliant samples	169	169	169	151	162	149	129	131	168	167	139	148	
Percent compliant	100	100	100	89	96	88	76	78	99	99	82	88	

Key to Table 2: Co – cobalt; Se – selenium; Cr(VI) – chromium (VI); Sb – antimony; As – arsenic; Ba – barium; Cd – cadmium; Pb – lead; Hg – mercury; Sn – tin; Zn – zinc; Cu soluble – copper soluble; Ni – nickel

Metal composition of tattoo inks varies greatly. Examples of tattoo ink colour shades used are: red, blue, green, yellow, orange, and white.^{7 8} Summary of the number of samples by colour shades that exceed the Guidelines is shown in Table 3. Detailed results are shown in Appendix 3. Figure 1 provides a graphical representation of the number non-compliant metals.

⁷ www.dermnetnz.org/reactions/tattoo-reaction.html

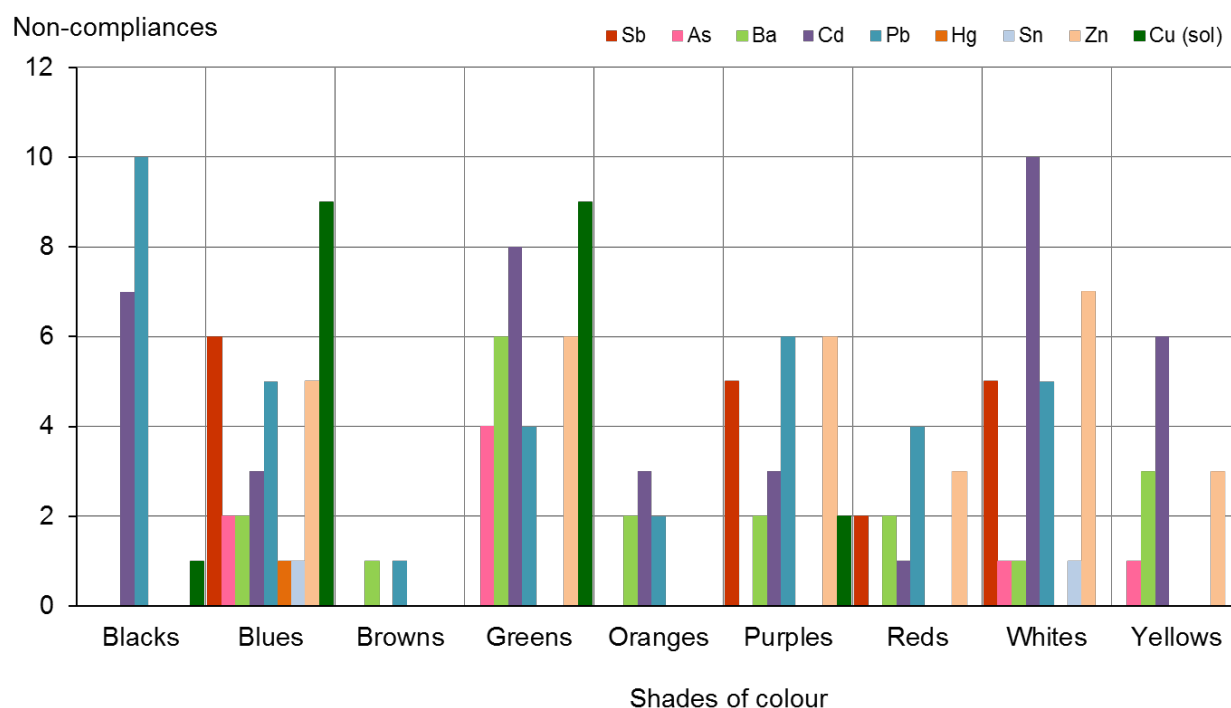
⁸ <http://rmcrayne.hubpages.com/hub/Tattoos-Health-Risks-and-Toxic-Effects>

Table 3: Number of non-compliant metals by colour shades* exceeding the EPA guidelines

	Reds	Oranges	Yellows	Greens	Browns	Blues	Purples	Blacks	Whites
Co									
Se									
Cr(VI)									
Sb	2					6	5		5
As			1	4		2			1
Ba	2	2	3	6	1	2	2		1
Cd	1	3	6	8		3	3	7	10
Pb	4	2		4	1	5	6	10	5
Hg						1			
Sn						1			1
Zn	3		3	6		5	6		7
Cu (sol)				9		9	2	1	
Ni									
Total of non-compliant metals	12	7	13	37	2	34	24	18	30

Key to Table 3*: Reds include pinks, fuchsias, magentas, and cherries – 20 colour-variants [28 samples]; Oranges: 9 colour-variants [12 samples]; Yellows include lemons and goldens – 11 colour-variants [17 samples]; Greens include teals, grasshoppers, and sea foams – 25 colour-variants [31 samples]; Brown includes coco – 1 colour-variant [1 sample]; Blues include cobalts and aquamarinas – 15 colour-variants [23 samples]; Purples include violets, turquoises, lavenders, and grapes – 13 colour-variants [17 samples]; Blacks include black washes, grey washes, and outlining ink – 15 colour-variants [24 samples]; Whites: 9 colour-variants [16 samples].

Note: A sample may contain more than one non-compliant metal.

Figure 1: Number of non-compliant metals by colour shades

Common ingredients of red-coloured inks are mercury and cadmium. Therefore, it was surprising that among the 28 samples (20 colour-variants) of red analysed, all met the mercury guideline with only one exceeding the cadmium guideline. There were a total of 30 non-compliant metals in this colour shade.

Yellow-coloured inks commonly contain lead, cadmium and zinc. Among the 11 colour-variants of yellow analysed, there were 25 non-compliant metals. Six exceeded cadmium; three exceeded the zinc while all yellows had lead levels that meet the Guidelines.

Orange-coloured inks commonly contain cadmium. There were nine colour-variants of orange samples tested and 16 non-compliant metals were recorded. Eight exceeded the cadmium guideline value.

Common ingredients of green-coloured inks are lead, chromium and copper. Twenty five colour-variants of green were analysed with 67 non-compliant metals recorded. There were four lead and nine copper that exceeded the Guidelines. All green-coloured samples were below the limit of detection for chromium VI.

Blue-coloured inks commonly contain cobalt and copper. Of the 15 colour-variants of blue analysed, there were 56 non-compliant metals. All samples tested were below the guideline for cobalt while there were nine that exceeded the guideline for soluble copper. One non-compliant soluble copper was at a level 1000 times greater than the Guidelines.

White inks commonly contain lead, zinc and barium. There were 16 white samples analysed with 43 non-compliant metals. Five exceeded the lead guideline while seven exceeded the zinc guideline. All samples tested were below the guideline for barium.

Because all colour samples were tested for the presence of all the heavy metals listed in the Guidelines, analysis also identified that 'main' colour shades contain other heavy metals that exceed the Guidelines (refer Table 3), in that some of the:

- red colour shades also contain antimony, barium, and lead
- yellow colour shades also contain barium and arsenic
- blue colour shades also contain antimony, arsenic, lead and cadmium
- white colour shades also contain antimony, cadmium and arsenic
- orange colour shades also contain lead and barium
- green colour shades also contain cadmium, barium, zinc and arsenic.

Table 4 presents the number of non-compliant metals by product brand. Detailed results are shown in Appendix 3. A graphical representation of the non-compliant metal by brand is shown in Figure 2.

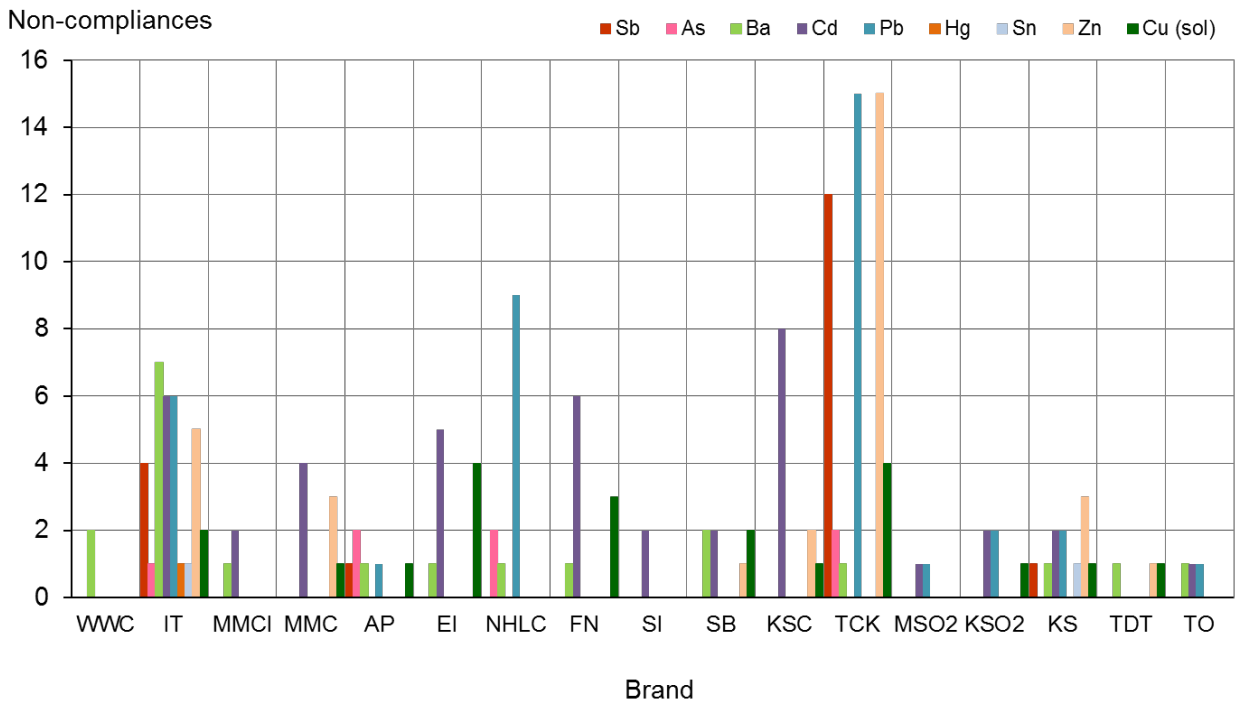
Table 4: Non-compliant metals by product brand

	Co	Se	Cr (VI)	Sb	As	Ba	Cd	Pb	Hg	Sn	Zn	Cu (sol)	Ni	Total
WCC						2								2
IT				4	1	7	6	6	1	1	5	2		33
MMCI						1	2							3
MMC							4				3	1		8
AP				1	2	1		1				1		6
EI						1	5					4		10
NHLC					2	1		9						12
FN						1	6					3		10
SI							2							2
SB						2	2				1	2		7
KSC							8				2	1		11
TCK				12	2	1		15			15	4		49
MS 1202							1	1						2
KS 1202							2	2				1		5
KS				1		1	2	2		1	3	1		11
TDT						1					1	1		3
TO						1	1	1						3

Key to Table 4:

WCC	Waverly Color Company	IT	Intenze	MMCI	Mom's Millennium Colourworks Inc
MMC	Mom's Millennium Colourworks	AP	Alla Prima	EI	Eternal Ink
NHLC	National HLC	FN	Fusion	SI	Silverback Inc
SB	Starbright	KSC	Kuro Sumi Color	TCK	Tattoo Color King
MS02	Makkuro Sumi 1202	KS02	Kuro Sumi 1202	KS	Kuro Sumi
TDT	Tang Dragon Tattoo	TO	Tattoo		

Figure 2: Number of non-compliant metals by product brand



* Number of non-compliant metals.

The brand that contains the highest number of non-compliant metals is Tattoo Colour King followed by the Intenze brand. The following brands presented the least number of non-compliant metals: Waverly Colour Company, and Silverback Ink (two each); Mom’s Millennium Colourworks Inc, Tang Dragon Tattoo and Tattoo (three each).

5 Conclusion

Bearing in mind the limited scope of the survey, the colour samples analysed were generally compliant with the maximum permissible levels of heavy metals specified in the Guidelines. Samples tested were 100 percent compliant with cobalt, selenium and chromium (VI) guideline levels. The compliance for nickel cannot be commented on due to the technical uncertainties in minimising the level of nickel as a result of good manufacturing practice. The level considered to be 'as low as technically achievable' for nickel is unable to be specified at the time of this survey, and so no comment is made on non-compliance with respect to nickel levels.

Some samples contain metals which are orders of magnitude greater than the Guidelines and may likely pose public health risk.

Different colour-variants within a 'colour shade' vary in the levels and the number of metals present. The green colour shade appears to contain the highest number of non-compliant metals followed by the blues and the whites. Browns contain the least number of non-compliant metals followed by the orange colour shade, where one sample and 12 samples were tested respectively. With respect to product brands, Mom's Millennium Colourworks Inc, Tang Dragon Tattoo and Tattoo appeared to be the most compliant brand noting that there were only very few samples tested under these brands.

Because of the limited number of samples collected and analysed, these results should be treated with caution and should not be extrapolated to draw conclusions about the heavy metal quality of tattoo inks, either colour shades or brands that were not included in this survey.

6 Recommendation

It is recommended that:

- this report be copied to the District Health Boards, EPA, the Ministry of Business Innovation and Employment (Health and Safety Group), and the New Zealand Tattoo Association for their information
- maintain a watching brief on the research being carried out on tattooing practices and risks. Health risk assessment studies for tattoo inks are only now emerging internationally. It is acknowledged that the toxicology of tattooing is poorly understood and a number of uncertainties need to be addressed before a systematic health risk assessment can be performed. Toxicology studies usually look at inhalation, ingestion, skin contact and injection into the blood. Applying chemicals under the skin is unique and a better understanding of the body's response to tattoo inks and the impact of inks on human health is required. Internationally, there is little understanding of what happens when inks are broken down in the body. Evaluating exposures is also an area of significant uncertainty, for example there is no information about how much of the ink deposited in the tattooed skin area is absorbed into the body.

Appendix 1: Number of samples and brands collected from each website

Name of suppliers (website)	Product brand	Total number of samples
www.waverlycolor.com	Waverly Color Company	11
www.unimaxwest.com	Intenze	9
	Moms Millennium Colourworks Inc	5
	Eternal Ink	11
www.unimaxshop.com	Mom's Millennium Colourworks	7
	Alla Prima	11
www.nationaltattoo.com	National HLC	11
www.fusiontattooink.com	Fusion	11
www.silverbackink.com	Silverback ink	9
www.tommysupplies.com	Starbright	11
www.tattoosupply.co.nz [#]	Kuro Sumi Colour	11
www.lightinthebox.com [*]	Tattoo Colour King	28
www.yuelongtattoo.com [*]	Makkuro Sumi	1
	Kuro Sumi 1202	2
	Intenze	17
	Kuro Sumi	7
	Tang Dragon	4
	Tattoo	3

New Zealand

* China

Others USA

Appendix 2: List of colours sampled

Product brand	Colour
Waverly Color Company	Red; orange; yellow; white, lime green; green; blue, magenta; purple; sea foam; dark black
Intenze	Ruby red; hard orange; lemon yellow; snow white opaque; dark green; Mario's blue; true magenta; teal; true black
Moms Millennium Colourworks Inc	Snote green; forest gump green; magic magenta; purple purple; tropical teal
Mom's Millennium Colourworks	Agent orange; piss yellow, power white; blue balls
Alla Prima	Primary (p) red; p orange; p lemon; p white; p light green; p forest green; p cobalt; p true purple; p violet; p teal; p black
Eternal Ink	Dark red; bright orange; bright yellow; white; jungle green; green conc; blue conc; magenta; purple conc; turquoise; triple black
National HLC	Indian red; naval orange; buttercup yellow; white on white; spring green; hunter green; midnight blue; brilliant magenta; deep purple; liquid turquoise; real black concentrate
Fusion	True blood red; mandarin orange; mixing yellow; white; gamma green; emerald green; power green; dark magenta; deep purple; Tahitian teal; basic black
Silverback Ink	Grey wash series; silver back white; silver back black; grey wash series – fresh
Starbright	Scarlet red; brite orange; canary yellow; brite white; lime green; deep green; deep blue; deep magenta; deep purple; teal; turbo black
Kuro Sumi Colour	Chi red; rising sun orange; golden yambuki; white rice mixing; kane green; green apple blossom; buddha blue; Mt Fuji magenta; murasaki purple; kamikaze blue; tattoo outlining ink
Tattoo Colour King	Grasshopper; country blue; crimson; teal; bright orange; lavender; dark red; aquamarina; baby blue; golden yellow; true black; cherry bomb; white; grape
Makkuro Sumi 1202	Grey wash shading tattoo ink
Kuro Sumi 1202	Tattoo outlining ink; grey wash shading ink
Intenze	Bright red; bright orange; lemon yellow; snow white opaque; dragon green; Marios light blue; fuchsia; light purple; aquamarina 102; true black 102; snow white mixing; aquamarina; baby blue; Co-co
Kuro Sumi	Black; forest is green; tsunami blue; dark red; violet violet; deep yellow; white
Tang Dragon Tattoo	Carols pink; golden yellow; baby blue; dragon green
Tattoo	Blue; red; black

Appendix 3: Concentrations of heavy metal present

Appendix 3a: antimony

Antimony (2 mg.kg)*	Number of samples	Brands
<1.0 [#] -2	151	Meet EPA Guidelines
3.0-10	1	Alla Prima (primary white)
	2	Tattoo colour king (county blue)
	3	Intenze (Marios light blue) Intenze (snow white mixing; snow white opaque)
	1	Kuro Sumi (white)
11-20	4	Tattoo colour king (baby blue; grape)
21-30	3	Tattoo colour king (crimson; lavender)
31-40	3	Tattoo colour king (lavender; white)
...		
147	1	Intenze (light purple)

* Maximum concentration in EPA Guidelines.

Values '<1.0' are below the limits of detection levels for antimony.

Appendix 3b: arsenic

Arsenic (2 mg.kg)*	Number of samples	Brands
<0.10 [#] -2	162	Meet EPA Guidelines
3.0-10	2	National HLC (butter cup yellow; midnight blue)
	2	Tattoo colour king (teal)
	1	Intenze (baby blue)
	1	Alla Prima (primary teal)
...		
50-60	1	Alla Prima (prima white)

* Maximum concentration in EPA Guidelines.

Values '<0.10' are below the limits of detection levels for arsenic.

Appendix 3c: barium

Barium (50 mg.kg)*	Number of samples	Brands
<0.2 [#] -50	149	Meet EPA Guidelines
>5-100	5	Intenze (teal; aquamarina) Mom's Millennium Colourworks Inc (purple nurple) Tattoo Colour King (grasshopper) Tang Dragon (dragon green)
101-200	3	Eternal Ink (purple conc) Intenze (ruby red; Marios light blue)
201-400	4	National HLC (spring green) Intenze (Co-co; bright orange) Kuro Sumi(white)
...		
701-800	1	Alla Prima (primary orange)
...		
1,000-11,000	4	Waverly Colour (yellow) Fusion (gamma green) Starbright (canary yellow) Tattoo (red)
11,001-17,000	3	Waverly colour (lime green) Intenze (lemon yellow) Starbright (lime green)

* Maximum concentration in EPA Guidelines.

Values '<0.20' are below the limits of detection levels for barium.

Appendix 3d: cadmium

Cadmium (0.20 mg.kg)*	Number of samples	Brands (colours)
<0.1 [#] –0.20	129	Meet EPA Guidelines
0.21–0.30	6	Kuro Sumi Colour (rising sun orange) Eternal Ink (turquoise) Fusion (deep purple; emerald green) Intenze (true black) Kuro Sumi 1202 (tattoo outlining ink)
0.31–0.40	11	Intenze (teal; true black) Moms Millennium Colourworks Inc (snot green) Eternal Ink (bright orange; jungle green) Fusion (mandarin orange) Silverback Ink (silver back white) Kuro Sumi Colour (buddha blue; murasaki purple; kamikaze blue)
0.41–0.50	9	Moms Millennium Colourworks Inc (tropical teal) Eternal Ink (bright yellow) Fusion (Tahitian teal) Kuro Sumi Colour (chi red; golden yambuki; green apple blossom; black) Tattoo (black) Makkuro Sumi (grey wash)
0.51–0.60	6	Moms Millennium Colourworks (piss yellow) Eternal Ink (white) Fusion (mixing yellow; white) Kuro Sumi Colour (white rice mixing) Intenze (Marios light blue)
0.61–0.70	6	Intenze (snow white opaque) Moms Millennium Colourworks (piss yellow) Starbright (brite white; teal) Kuro Sumi (greywash shading)
0.71–0.80	2	Moms Millennium Colourworks (power white) Kuro Sumi (white)

* Maximum concentration in EPA Guidelines.

Values '<0.10' are below the limits of detection levels for cadmium.

Appendix 3e: chromium (VI)

Chromium VI (0.20 mg.kg)*	Number of samples	Brands
ND	169	Meet EPA Guidelines

* Maximum concentration in EPA Guidelines.

Values 'ND' are below the limits of detection levels for chromium VI.

Appendix 3f: cobalt

Cobalt (25 mg.kg)*	Number of samples	Brands
<0.5–5.0	169	Meet EPA Guidelines

* Maximum concentration in EPA Guidelines.

Values '<0.50' are below the limits of detection levels for cobalt.

Appendix 3g: copper, soluble

Copper, soluble (25 mg.kg)*	Number of samples	Brands
<0.1–25	43	Meet EPA Guidelines
26–30	1	Moms Millennium Colourworks (blue balls)
31–35	1	Kuro Sumi 1202 (grey wash: shading ink)
...		
40–45	1	Intenze (Marios light blue)
...		
75–80	2	Kuro Sumi Colour (Kamikazi blue) Eternal ink (turquoise)
...		
150–200	5	Tattoo Colour King (country blue) Tattoo Colour King (baby blue) Alla Prima (primary teal)
205	1	Fusion (gamma green)
258	1	Starbright (deep blue)
332	1	Eternal ink (purple conc)
405	1	Kuro sumi (forest is green)
423	1	Fusion (emerald green)
983	1	Intenze (dragon green)
1730	1	Starbright (deep green)
1860	1	Fusion (power green)
2300	1	Intenze (dragon green)
3590	1	Eternal ink (green conc)
32900	1	Eternal ink (blue conc)

* Maximum concentration in EPA Guidelines.

Values '<0.10' are below the limits of detection levels for soluble copper.

Note: Only the 64 colour samples that exceeded the maximum concentration of total soluble Cu of 25 mg/kg were tested.

Appendix 3h: lead

Lead (2 mg.kg)*	Number of samples	Brands
<0.1–2.0	131	Meet EPA Guidelines
2.1–10	26	Alla Prima (primary orange) National HLC (white on white, spring green; hunter green, midnight blue; brilliant magenta; liquid turquoise) Tattoo Colour King (teal; lavender; aquamarina; baby blue; white; grape; crimson) Intenze (snow white opaque, Marios light blue; light purple; show white mixing; Co-co) Kuro Sumi (white)
11–20	5	National HLC (indian red, naval orange) Tattoo Colour King (true black) Tattoo (black) Kuro Sumi Colour (tattoo outlining ink)
21–30	3	Intenze (true black) Tattoo Colour King (true black)
31–40	3	Makkuro Sumi (grey wash shading tattoo ink) National HLC (red black) Kuro Sumi (black)
41–45	1	Kuro Sumi 1202 (grey wash shading ink)

* Maximum concentration in EPA Guidelines

Values '<0.10' are below the limits of detection levels for lead.

Appendix 3i: mercury

Mercury (0.2 mg.kg)*	Number of samples	Brands
<0.1–0.2	168	Meet EPA Guidelines
0.6	1	Intenze (Marios light blue)

* Maximum concentration in EPA Guidelines

Values '<0.10' are below the limits of detection levels for mercury.

Appendix 3j: nickel

Nickel (as low as technically achievable)*	Number of samples	Brands
<0.20–0.20	36	Waverly Colour (yellow; white; magenta; orange) Intenze (true black; lemon yellow; Co-co; true black; true magenta; snow white mixing) Moms Millennium Colour Works Inc (magic magenta) Alla Prima (primary red, primary orange, primary lemon; primary light green, primary black) Eternal Ink (magenta) National HLC (indian red; naval orange; buttercup yellow; white on white; real black concentrate) Fusion (dark magenta) Silverback Ink (grey wash series; silver back black; grey wash series-fresh) Starbright (turbo black) Kuro Sumi Colour (Mt Fuji magenta) Kuro Sumi (tsunami blue; dark red; violet violet) Tang Dragon (Carol's pink; golden yellow)
0.30–22.8	133	Others

* 0.2 ppm as per analytical technique used by Environmental Laboratory Services.

Values '<0.20' are below the limits of detection levels for nickel.

Appendix 3k: selenium

Selenium (2 mg/kg)*	Number of samples	Brands
<0.5–2	169	Meet EPA Guidelines

* Maximum concentration in EPA Guidelines.

Values '<0.50' are below the limits of detection levels for selenium.

Appendix 3l: tin

Tin (50 mg/kg)*	Number of samples	Brands
<1–50	167	Meet EPA Guidelines
...		
88	1	Intenze (Marios light blue)
101	1	Kuro Sumi (white)

* Maximum concentration in EPA Guidelines.

Values '<1.0' are below the limits of detection levels for tin.

Appendix 3m: zinc

Zinc (50 mg/kg)*	Number of samples	Brands
<1-50	139	Meet EPA Guidelines
51-60	5	Moms Millennium Colourworks (piss yellow) Kuro Sumi Colour (white rice mixing, green apple blossom) Intenze (snow white opaque)
61-70	4	Intenze (snow white opaque; Marios light blue) Moms Millennium Colourworks (power white) Starbright (teal)
71-100	2	Kuro Sumi (white) Starbright (brite white)
101-200	3	Tattoo Colour King (teal, country blue)
201-300	2	Tattoo Colour King (country blue)
...		Intenze (light purple)
501-600	2	Tattoo Colour King (grape) Intenze (fuschia)
601-700	2	Tattoo Colour King (baby blue) Tang Dragon (dragon blue)
701-800	3	Tattoo Colour King (crimson; baby blue; grape)
..842	1	Tattoo Colour King (crimson)
...1050	1	Kuro Sumi (violet violet)
...1060	1	Tattoo Colour King (lavender)
...1130	1	Tattoo Colour King (lavender)
...1290	1	Tattoo Colour King (white)
...1430	1	Tattoo Colour King (white)
...1640	1	Kuro Sumi (forest is green)

* Maximum concentration in EPA Guidelines

Values '<1.0' are below the limits of detection levels for zinc.