CURRENT LEVELS OF LEAD IN PAINT SOLD IN NIGERIA

A Case Study by N.C.Ahamefuna*[a]; O.Osibanjo[a]; A.A.Sunday[b]and E.C.Ogoko ,[c] Nigeria

([a]Dept of Chemistry, University of Ibadan, Nigeria
[b]Dept of Human Kinetics and Health Education, University of Calabar
[c]School of Science and Technology,National Open University of Nigeria)
Email: ahech@yahoo.com

ABSTRACT

Serious health effects of lead poisoning have elicited global campaign to eliminate lead use in paint. The major challenge is the dearth of data on lead levels in paints from developing countries. Thus lead levels of paints manufactured and sold in Nigerian market were studied. Lead concentrations from 59 paint samples involving 10 different shades were determined using flame atomic absorption spectrophotometer (AAS).

It was found that 83 % of the enamel paints had higher than the approved levels of lead in some countries which are 90µg/g and 600µg/g. The lead concentrations in the paint obtained ranged from 22.5µg/g to 74175µg/g, with mean value of 6442.88µg/g and median value of 1685µg/g. The concentration of lead was very high in almost all the enamel paints which make up over 80 % of the paint samples.

Plastic paints (emulsion paint)generally contained low lead levels (22.5 µg/g -80.5 µg/g). Analysis shows that there is no significant difference between the concentration of lead and the colours of the paint sampled. Thus all the paint manufacturers are still using lead containing pigment in their paint production. Efforts should be made by regulatory authority to spearhead campaign to phase out lead use in paint.

KEYWORDS: Lead level, Paint, regulation, Heavy metal Nigeria,

INTRODUCTION

Lead is one of the few heavy metals that have influenced the world both for good and for bad. Its extensive use by the Romans made lead to be popularly referred to as a Roman Metal (Nriagu *et al.*,2009). Though lead has contributed in no small measures to Industrial development, its dangerous health effects on humanity and animal alike have not gone unnoticed down to this day. Much of our exposure to lead comes from human activities including the use of fossil fuels including past use of leaded gasoline, some types of industrial facilities, and past use of lead-based paint in homes.

Lead and lead compounds have been used in a wide variety of products found in and around our homes, including paint, ceramics, pipes and plumbing materials, solders, gasoline, batteries, ammunition, and cosmetics. The evidence of its hazard potential, especially to children is overwhelming. Reducing such environmental health hazard is one of the 8 main goals of the United Nations millennium development goals(Osibanjo,2005).Fatal health effects (Lead poisoning) to neonates, children and pregnant mothers are associated with exposure to lead in paint due to the high absorbing potential of their developing neural system. Because lead is persistent in the environment, its release may persist for years after the paint has been applied to surfaces.

Weathering activities cause paint to lose its binding properties and thus peel, flake and eventually become dust that can settle on objects that children play with or on utensils at home. Children habitually tend to pick objects into their mouth as they explore their surroundings, and as a result may leak lead dust on those objects. When lead gets absorbed into the bloodstream, it bio accumulates and with time, the effects become manifest in various ways.

The social and health effects of these high lead concentrations include reduction in intelligent quotient scores, hyperactivity, shortened concentration spans, poor school performance, increasing tendency towards aggressiveness and learning loss, organ failure, infertility in male and miscarriages in female (Needleman,2004).

A number of studies have been conducted on lead use in consumer products such as premium motor spirit(PMS), paints, toils and plastics. The overwhelming evidence of the high lead concentrations in these consumer products as well as the attendant publicity, has successfully led to the total phase-out of lead in petrol (Kumar and Gottesfeld, 2008; Clark *et al*., 2009; Adebamowo *et al*., 2007). The extent of that global attention that effected lead phase out from petrol has so far not been extended to lead use in paint(Montgomery and Mathee, 2005).

Considering that, for over a century now, the need to remove lead use in paint was first mentioned and further reiterated by international labour organization (ILO), not so much appear to have been done to eradicate lead use in paint (Gibson, 1904; ILO, 1921; Canfield*et al., 2003).*

In many developing countries attention is more often given to disaster caused by lead exposures from smelters and battery-recycling operations than from consumer products. In the most recent human disaster episode in Nigeria, over 300 persons died in some local government areas of Zamfara state and Niger state, as a result of poisonous lead gases emanating from mineral mining sites in those area (The Nigerian Guardian, June ,2010;WHO,2010).

The global body stated that a random sample of 56 children under the age of five from the affected villages of Abare and Tunga-guru found that more than 90% of them had lead poisoning, with the vast majority requiring urgent treatment. The report stated that death occurred predominantly in children under 5 years. Lead concentrations in soils greater than 10000µg/g were found around habitations in those villages. (CNN, 2010).

Similar incident occurred in a battery recycling plant in the city of Thiaroye SurMer, 2008.Some 17 deaths were reported and scores of resident poisoned. In China, 15000 people from 10 different villages were

relocated from Jiyuan in central Henan Province to another location after about 1000 children living around China's largest smelter plant died (Reuters, 2009; AFP, 2009; Watts, 2009).

WHO (2010),has identified lead in paint as one of the 20 risk factors contributing to global burden of disease with 40 % of children having blood lead levels greater than 5µg/dl of which 97 % are from developing countries.

Subsequently, the United Nation Environment Program (UNEP), rising from the World summit on sustainable development through its Strategic Approach to International Chemical management (ICCM) and International Forum for Chemical Safety (IFCS) has Placed their plan of implementation on the total phase out of the sale and manufacture of Paint-containing lead(SAICM/ICCM/INF/38, 2008).

The acceptable and holistic practical approach necessary for preventing lead Poisoning in children and adult is the identification and reduction of all possible sources of lead exposure, paint inclusive(Meyer.*et al*,2003). Markowitz (2000), stated that many Countries had placed regulations on lead limit in paint.

Only a few reports on lead use in paint from Africa has so far been documented. In Johannesburg South Africa, Montgomery and Mathee (2005), observed that despite the voluntary agreement to limit lead used in paint increasingly high lead concentrations continued to be used. The study found that, one sample from one of the newest suburbs contained lead concentrations as high as 29000µg/g. The average concentration in the newest suburb rose to an all-time high of 5940µg/g. Since 2008, a maximum limit of600µg/g had been put in place by the Department of Housing South Africa.

In Nigeria Adebamowo *et al*(2007), analysed 25 samples of enamel paint which consisted of 5 different colours from 5 different manufacturers and observed that the lead concentrations exceeded 600µg/g. The reported mean and median respectively were 14500µg/g and 15800µg/g which varied by colour with yellow colour registering the highest. A report has also been carried out in Tanzania on the lead levels paints. The report showed that of the 26 paint samples, 20 were enamel paint. All enamel paints had concentrations greater than 90 µg/g while 19 of the enamel samples exceeded 600 µg/g, which also exceeded the voluntary lead limit of 450 µg/g in Tanzania. In all, 77 %exceeded 90 µg/g.

Senegal study showed that 86% of enamel paint sample had concentration greater than 90 µg/g while 76% of the enamel paints were higher than 600 µg/g, an average of 4108.2 µg/g(Kumar,2009).

As the first nation to set up an environmental agency (USEPA) in 1970, United States has taken numerous measures to reduced human exposure to lead. Since the passage of the lead-based paint poisoning prevention act, other laws have been passed to regulate hazardous chemicals including leaded paint. Some of these laws include Lead-based paint poisoning prevention act, Residential lead-based paint hazard reduction act, Children's products containing lead act.

EPA established a safety standard for renovation, repair and painting work that disturbs lead paints in target housing and child-occupied facilities built before 1978.This became effective from April 22, 2010. US states have employed similar measures to check lead in consumer products. Other agencies and departments of the US such as: Food and Drug Administration (FDA), Department of housing and urban development ,Occupational Safety and Health Administration(OSHA), Consumer Product Safety Commission have synergized the campaign to reduce exposure to lead in paint .

Presently USEPA allows a maximum lead limit of 90µg/g. This was sequel to the import and recall of millions of lead-based paint contaminated toys from China(LawLib.,2010). This effort and the awareness already created is yielding positive result as the percentage of housing containing lead-based paint is on the decrease (Wilson *et al*,2006; Jacobs *et al* , 2002; Clark *et al* , 2009).

In India, Kumar and Gottesfeld (2008), observed that the 38 samples of new latex paint sampled contained lead concentrations lower than the national limit of 600 µg/g. Inthe 31 samples of enamel paint analysed, over 83 % of the enamel paint brands were very high in their lead content. The mean lead concentration of the enamel paint was about26000 µg/g .

Earlier report on lead levels in the blood of 10 Indian children discovered that contamination from lead-based paint could have been responsible for the high blood lead level in at least 3 of the children since the home of 3 of the ten children contain leaded paint (Kuruvilla *et al.*, 2004). Notoriously high lead concentration were also found in new Chinese paints despite regulation prohibiting levels greater than 600µg/g. Lin *et al.(2008),*noted that 24% of the 59 samples of enamel paint contained lead levels greater than or equal to 5000µg/g. About 50% of the sample registered levels greater than or equal to 600 µg/g.

Bright colours of yellow, green and red paints were especially high. In a separate study conducted by Lin et *al* (2008), in 12 Nursery schools and 12 primary schools in China, 28samples in all were collected from school walls, toys and furniture. The values indicated that 57 % of the samples were similarly greater than or equal to 600 µg/g and 21% were greater than 5000 µg/g as in the new decorative paints as in the new decorative paint earlier studied.

There is dearth of information on lead concentrations in Nigerian paints, as study by Adebamowo in 2007, only sampled 5 manufacturers. More such studies are therefore needed to better inform the international community and to assist in policy formulation that will lead to the total phase out of lead use in paint. It is worthy of note that apart from WHO,UNEP and its subsidiary IFCS,SAICM/ICCM, other nongovernmental organizations (NGOs) have put up concerted effort to enlighten the international community on the health hazard posed by lead in paint .The SAICM proposed global partnership for cooperation to phase out lead in paint had their first meeting in Geneva Switzerland in May 2010.

MATERIALS AND METHODS

The 59 paint sample of different colours brands and different colours brands and manufacture were collected from different retail shops depots as well as paint company around 3 major cities of Nigeria where there are high volume of paint manufacture and use. Six of the samples were water based paint (Emulsion paint or Plastic paint). The choice of small sample for the emulsion paint was informed by reports which had shown that water based paint contains very low concentrations of lead (Adebamowo *et al,* 2007; Clark*et al,* 2006). The remaining 53 paint samples were oil based paint (enamel paint).

The samples were collected in plastic containers. Standard operating procedures for analysing lead in paint using hotplate or microware- based acid digestion and atomic absorption spectroscopy was adopted (USEPA, 2001b).Each of the wet paint samples was applied on a clean one square foot ($1ft^2$) glass surface

using different brush for each sample to avoid contamination. The samples applied were left to air-dry for 4 days. The samples were then scraped off the glass surface using new scraper per sample.

Thereafter, the scraped paint samples were crushed using mortar and pestle to make samples as homogenous as possible. Enamel paint samples were cut into small pieces using new scissors for each sample. About 2g each of the air dried sample was placed in a crucible and introduced into an oven at about $120^{\cdot c}$ for one hour to remove any moisture. About 1.og each of the oven-dried paint samples were then subjected to acid digestion.

The digestion vessels were then cooled to room temperature. The solution together with the precipitate was transferred to a 25ml conical flask and volume made up to mark with distilled water. The solution was allowed to settle and then filtered. Filtrate was collected in the pre-cleaned sample container. Sample blanks were also prepared in a similar way. All the digested samples were analysed for total lead concentration with flame Atomic absorption spectrophotometer using lead lamps.

The atomic absorption spectrophotometer was calibrated using metal reference standard solution before measurement. A buck scientific model 210 VGP flame atomic absorption spectrophotometer with air / nitrous oxide as air / oxidant flame and slit size 0.7nm was employed for instrumental analysis. This determination of lead was carried out at wavelength of 283.2nm. The detection limit and sensitivity checks for lead used were 0.80mg/Land 10 mg/L respectively. The linear range for lead was 20mg/L.

RESULTS

LEAD CONCENTRATION IN PAINT SAMPLE

Lead concentration by colour

Table 1 showing Average Lead concentration(µg/g dry weight) of household paint by colour and percentages equal to or exceeding 90 µg/g and 600 µg/g

Colour	**Number of samples**	**Average concentration** µg/g	**%≥90** µg/g	**%≥600** µg/g
white	7	2094.00	86	71
black	9	1637.39	100	44
Red/pink	10	6559.90	80	80
green	5	15303.00	100	80
yellow	4	170425.00	100	100

Premushroom/brown/chocolate	4	1158.38	75	25
blue	6	2136.04	66.67	66.67
Cream/offwhite	8	1019.34	62.5	25
gray	6	1889.625	83.3	66.67
total	59	202222.675		

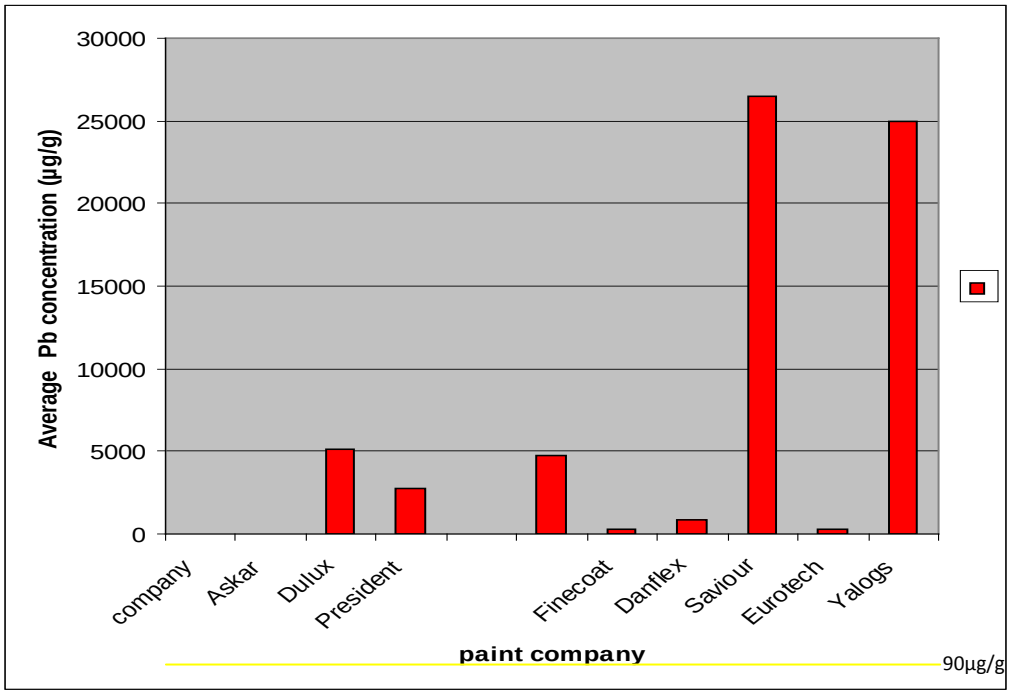

Figure 1.Bar chart showing concentration of Pb in µg/g of Redcolour paint from different companies

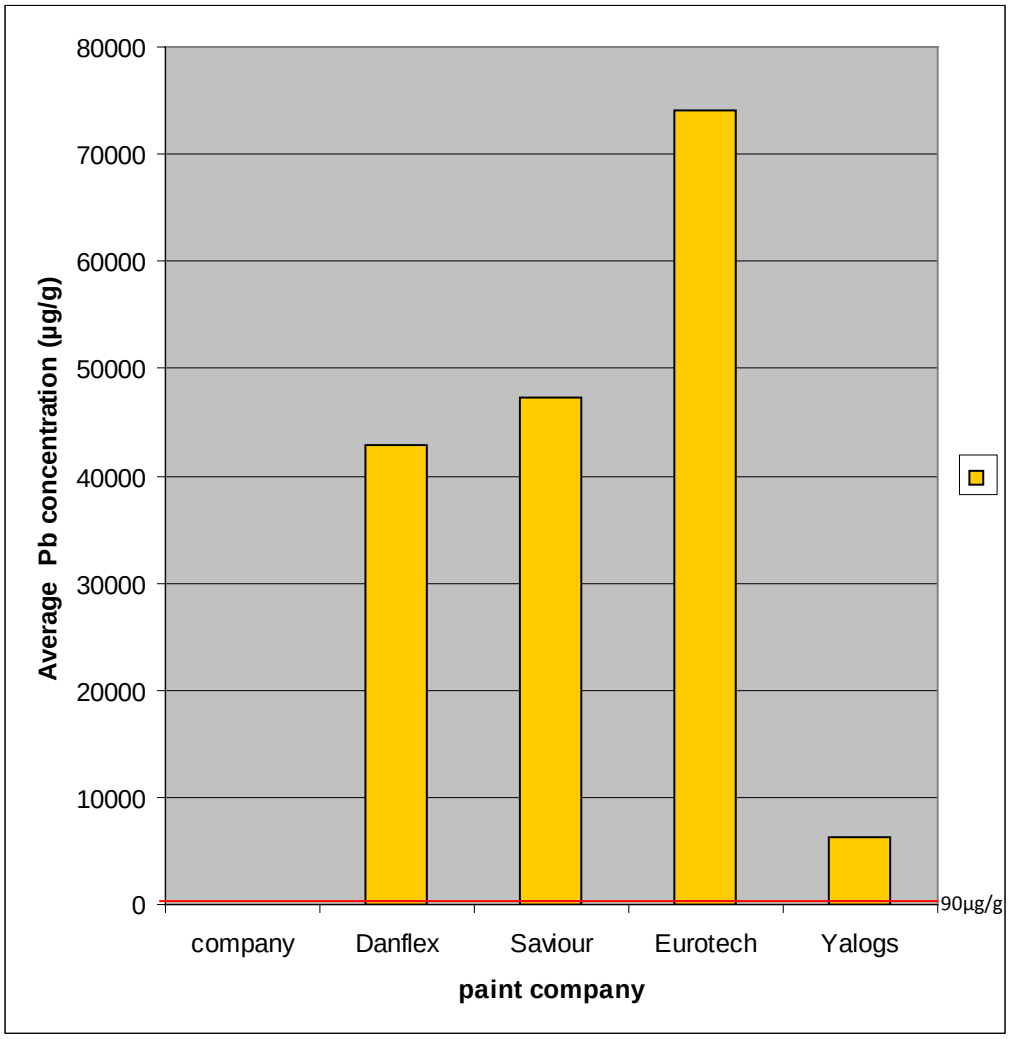

Figure 2. Bar chart showing concentration of Lead in µg/g of Yellow colour paint from different companies

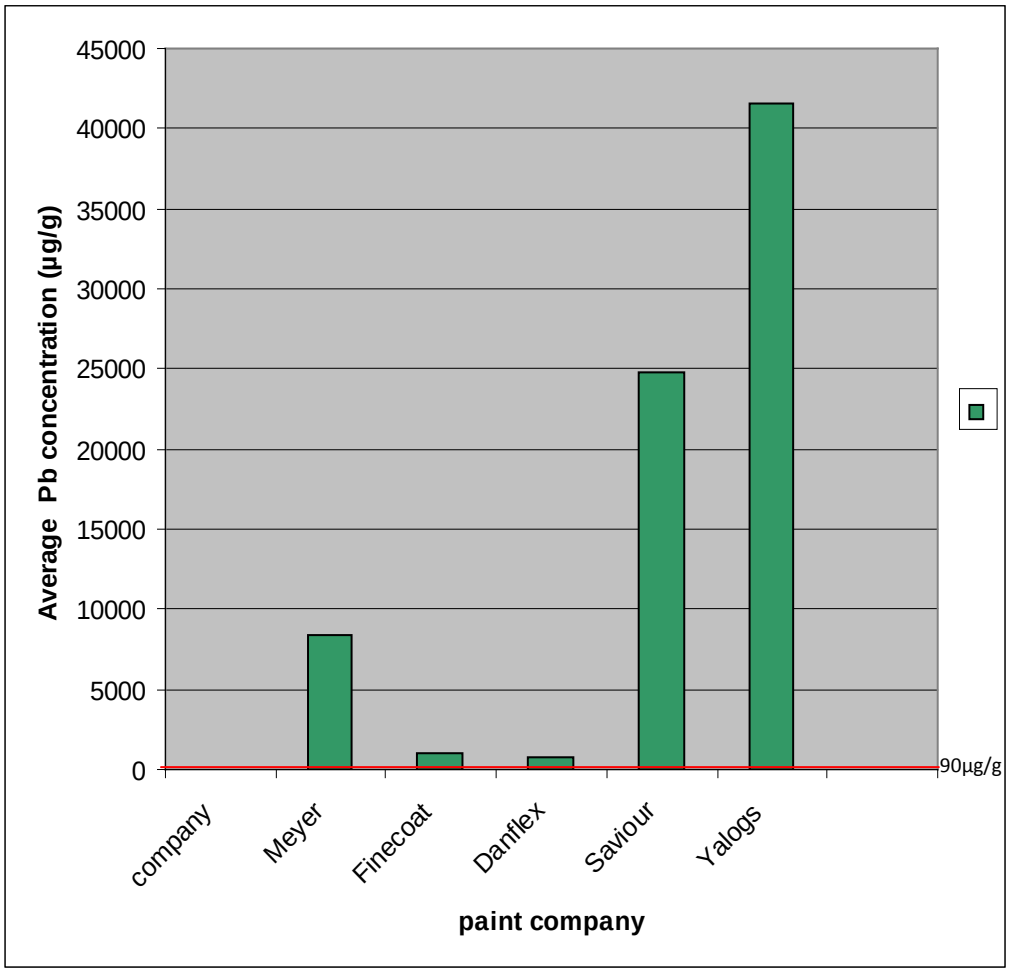

Figure 3. Bar chart showing concentration of Lead in µg/g of Green colour paint from different companies

The total average for yellow colour had the highest value of 170425 µg/g. This is followed by green (15303 µg/g) and red (6559.90 µg/g). The colours of yellow, green and black have 100% of their samples registering values that are greater than or equal to 90 µg/g. Only yellow colour had 100% of its sample greater than or equal to 600µg/g. The colour with the lowest total average is the cream/off-white colour. Only 7 samples of the enamel paint exceeded or equalled 10,000 µg/g.

CONCENTRATION OF LEAD IN DIFFERENT COLOURS BY COMPANY

A summary of average lead concentration of the different colours of paint types of some selected company sampled is presented in table 3.

Table 3 showing the Concentration of Lead in different colours of paint for some selected companies sampled

Eurotech paint

Colour	Paint type	Pb concentration1 (µg/g)	Pb concentration2 (µg/g)	Average concentration (µg/g)
Blue	Gloss	29.75	29.75	29.75
White	Gloss	685.00	675.00	680.00
Black	Gloss	1782.50	1587.50	1685.00
Yellow	Gloss	74175.00	74175.00	74175.00
Red	Gloss	320.25	262.00	291.25

Yalogs paint

Colour	Paint type	Pb concentration1 (µg/g)	Pb concentration2 (µg/g)	Average Pb concentration (µg/g)
National green	Gloss	41600.00	41550.00	41575.00
Red	Gloss	24950.00	24900.00	24925.00
Black	Gloss	436.00	435.50	435.75
Yellow	Gloss	6225.00	6225.00	6225.00
White	Gloss	2502.50	2502.50	2502.50

Danflex paint

Colour	Paint type	Pb concentration1 (µg/g)	Pb concentration2 (µg/g)	Average concentration (µg/g)
Red	Gloss	895.00	905.00	900.00
National green	Gloss	732.50	732.50	732.50
Golden Yellow	Gloss	42800.00	42750.00	42775.00
Black	Gloss	4095.00	4105.00	4100.00
White	Gloss	4577.50	4582.50	4580.00
Blue	Gloss	2370.00	2360.00	2365.00

Saviour paint

Colour	Paint type	Pb concentration1 (µg/g)	Pb concentration2 (µg/g)	Average concentration (µg/g)
Black	Gloss	4707.50	4702.50	4705.00
National green	Gloss	24825.00	24825.00	24825.00
Blue	Gloss	4090.00	4085.00	4087.50
Golden yellow	Gloss	47200.00	47300.00	47250.00
White	Gloss	3695.00	3705.00	3700.00
Red	Gloss	26425.00	26525.00	26475.00

Both Danflex paint and Saviour paint had highest concentrations (42750 µg/g) and 47250 µg/g in the yellow colours. Eurotech paint had the highest lead concentration (74175 µg/g) in all thecompanies sampled. All Yalogs paints samples exceeded 90 µg/g.

DISCUSSION

The results show that lead (Pb) concentration of paints produced in Nigeria exceeded the standard limit of Pb in paint in most developed and developing countries of the world. The new US limit of Pb in paint is 90 µg/g (90 ppm).China, South Africa and India have a limit of 600 µg/g Pb concentration in paint. Of the 59 samples analysed, it was observed that 83 % exceeded 90 µg/g Pb concentrations.

Also 61 % of the paint samples exceeded the 600 µg/g limit. It was observed that the level of Pb in paint was very high in Yellow, Green and Red colours. It was mainly the enamel gloss paint samples that had high Pb levels when compared to Emulsion (plastic) paints analysed.

The concentration values of lead obtained for enamel paint ranged from 27.00-74175.00 µg/g. The median value was 2502.50µg/g. Pb. This indicates that 50% of the enamel paint sampled contained over 2502.50 µg/g Pb which is about thirty times the lead limit in paint.

Most paint companies in the country sampled had Pb levels in the range of 22.5-5157.5 µg/g. The highest concentration among these top paint companies was from Dulux paint which had values up to sixty times the standard limit of lead in paint.

A comparison of colours shown in table 1 to 3 showed that yellow colour contained the highest lead concentrations (74175 µg/g, 47250 µg/g, 42775 µg/g, and 6225 µg/g). This was followed by green colours (41575 µg/g, 24825 µg/g) and red colours (26475 µg/g, 24925 µg/g) respectively. One way analysis of Variance showed that there was no significant difference between the concentration of lead and the colour of the paint samples.

This showed that all the paint companies sampled are using lead containing pigment in their paint production. All the emulsion paints sampled (6) contained lead concentrations far less than the standard limit of lead in paint as found in most developed countries. The mean lead concentration of plastic (emulsion) paint was 38.08 µg/g. The range being 22.50-80.50 µg/g. This result is similar to earlier reported level of lead in household paints used/sold in Nigeria (Adebamowo *et al*, 2007).

The bar charts (fig.4.1-4.10) equally showed that the high concentration of lead in yellow enamel paint, green enamel paint, and red enamel paint decreases respectively in that order. Earlier studies of lead in blood of Nigerians showed that over 70% of children had lead levels above 10 µg/dl (Wright *et al*., 2005).

The considerable level of lead in the blood have shown considerable increase in the death rate from various human activities which include occupational exposures such as mineral mining, working in lead battery manufacturing factory , waste collectors, inhaling fumes from leaded petrol vehicle, etc.

In many informed developing countries (not Nigeria) there has been new legislation on permissible lead limits in decorative paint in recent times. However, enforcement of compliance to this legislation appears not to be as keen. Data gap also exist in most developing countries mostly because of lack of awareness of the risk that lead in paint pose to the human health. The only available data from China, India and South Africa showed high levels of lead in new decorative enamel paint. It is important to note that these countries are major trading partners with Nigeria.

The international community ,UNEP,WHO and other arms of the united nations organization should expedite action at monitoring and checking trans boundary movement of hazardous chemicals which include lead pigments used in paint production. Since there are less toxic alternatives to lead pigment such as titanium oxide, iron oxide, Zirconium oxide, and various organic pigments, they should be used. Though this alternative may be a little bit costlier, the cost pales in comparison to the enormous long term health cost and danger posed by leaded paint.

CONCLUSION

Decorative household paints available in Nigeria contain very high amount of lead (83%).The bright colours of yellow (74175 µg/g, 47250 µg/g ,42775 µg/g, 6225 µg/g) green(41575 µg/g ,24825 µg/g) and red (26475 µg/g, 24925 µ g/g) have the highest concentration of lead in them (figs1-3) The levels in this study which varied significantly with colour had highest levels in the bright colour paints such as yellow, green and red.

The values did not vary with manufacturer indicating that all manufacturers were producing paint containing lead above the recommended values. The highest overall Pb concentration (74175 µg/g) was from Eurotech paint, which was over 800 times the lead limit in paint. In fact, almost all the paint samples from Eurotech paint except one (Blue), contained values greater than the recommended limit of 90 µg/g. In Yalogs paint, the highest level of lead (41575 µg/g) was found in green colour enamel paint which was about 450 times the standard limit. In fact, the entire Yalogs paint sample (5) exceeded90 µg/g Pb.

Saviour paints, similarly had lead levels that exceeded 90 µg/g in all the samples with the highest being 47250 µg/g, a value that is over 500 fold the 90 µg/g limit. The same was also true of Danflex paint. All the samples exceeded 90 µg/g Pb with the highest (42775 µg/g) being 480 times the standard limit.

Berger paint exceeded by 14 times the lead limit in the highest lead containing sample (Greycolour).All Meyer paint samples equally exceeded 90 µg/g Pb with the highest being 8410 µg/g which is over 90 times the recommended limit. Dulux paint had 57 times lead level greater than the recommended value. Askar paint and President Paints were equally high in lead content with the highest levels being respectively 29 times and 53 times greater than the standard limit of 90 µg/g.

In addition, it was deduced that the main determinant of the lead level was the color of the paint as all manufacturers surveyed were producing paint with high lead contents. The main reason why they do this is because of lack of regulation since one of the manufacturers with facilities in Nigeria, China and Singapore manufactures low lead level paint in the Singapore where there is good regulation but not in Nigeria
.

RECOMMENDATION

The major factor about lead level in paint is the use of lead pigment in paint production. It is indisputable that hazard posed by lead in the home environment is most often not given much attention. This may not be

unconnected with failure of health practitioners to suspect/diagnose toxicity due to subclinical (below the level that warrants health concern) levels of lead in blood .

Lead is a persistent bio accumulative substance (PBS) and dust and flakes from leaded paints are thus poisoning children and adults alike. There are no lead limits in paint in Nigeria. Therefore, urgent steps and global partnership should be taken to nip in the bud further lead poisoning from lead in household decorative paint.

THERE SHOULD BE REGULATION AND MONITORING:

Lead use in paints is not regulated in developing countries. Therefore, it is important to enact mandatory national regulations for reducing at minimum lead concentrations in paints. This study has identified that bright colours of yellow, green and red are mostly very high in lead content.

Local consumer product regulators such as Standard organization of Nigeria (SON), NAFDAC, Customs, Immigration, NESREA etc. should wake up to their responsibilities by not only enacting specific regulation that will check lead use in paints and consumer product but also, enforce meaningful compliance with the enacted regulation. Imported products should be thoroughly screened so as to isolate leaded consumer products that should be recall back to country of origin. There should be total ban and removal of leaded paint from factories, depots and retail shops.

Safety measures must be put in place

Painters and decorators in the workplace should adopt safety measures such as the use of a nose mask, respirator, wearing eye protection device and other personal protective equipment. The paint industry should include a lead free paint symbol (label) on products without lead as a mark of high quality.

Public awareness program should be developed and implemented

Public awareness on lead toxicity is extremely low in developing countries. A mass campaign should be launched to educate and make people aware (especially painters, architects, and the paint industry) of the hazards associated with lead.

There should be Environmental impact assessment

Environmental impact assessment should be carried out to ascertain human exposure to lead in paint .This assessment should involve determination of exposure sources and the extent of lead in blood of Nigerians especially the most vulnerable group which are the children and pregnant
women.

Global partnership should be encouraged

Concerted efforts should be made to encourage partnerships among the civil society organizations and other stakeholders in the developing region of the world in order to ensure that lead is eventually eliminated from

paints worldwide. Also a coordinated and organized network of NGOs such as IPEN, Toxic links, FOTE, AGENDER, and civil society organizations should be involved in achieving the targets. The paint industry and health care professionals should set guidelines and modalities to reduce exposure to lead .The Global Partnership on Lead in Paints formed under UNEP and WHO at the May 2009ICCM2 which was further consolidated at the initial organizational meeting in May 2010 is a welcome development. Further, industry through its global outreach and partnerships of various sorts must work to eradicate this preventable problem.

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