**A COMPARATIVE CHROMATOGRAPHIC ANALYSIS OF FRESH AND SPOILT PAINTS FROM LAGOS, NIGERIA**

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**ABSTRACT**

Paints improve appearance of surfaces by conferring colour and sheen in addition to their protective function from sunlight, dust and moisture. Gas chromatography mass spectrometry (GC-MS) analysis of six fresh and six spoilt paint samples was carried out to monitor the quality of the paint samples and determine the variations in chemical composition before and after spoilage. The chromatographic analysis of spoilt paint samples showed the abundance of esters and alcohol derivatives including cyclohexane, octane, 3-tetradecene, silane, diethoxydimethoxy, hexadecane, benzene, 2- [tert-butyldimethylsilyl)oxy]-1 and oleic acid which are indicative of paint degradation. On the other hand, the fresh paint samples had an abundance of 1-propanol, 2-(2-hydroxypropoxy), propanoic acid, 2-methyl-, 2,2-dimethyl-1-, propanoic acid, 2-methyl, 2-ethyl-3-hydro dodecane, 2-methyl-, 3-hydroxy-2,4,4 tridecane and 2,2,4-trimethyl-1,3-pentanediol which indicate the presence of the undegraded vinyl propionate copolymers and wholesomeness of paint samples. The compounds reported can serve as chemical markers for the quality control of paints.

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|  **Keywords:** Fresh paint, Spoilt paint, GC-MS, Degradation |

**INTRODUCTION**

Paints are composed of different chemical compounds such as pigments, binders, solvents,thickeners, additives and varied chemical elements, that are mechanically stable (Odokuma *et al,* 2013). They have been defined as uniformly dispersed mixture, with viscosity ranging from a thin liquid to a semi-solid paste, consisting of a pigment suspended in a liquid vehicle such as oil or water (Obidi *et al.,*2009). Primarily, paints are used for identification, colouring and protection (Talbert and Rodger, 2007). They have different basic qualities which include consistency, opacity (hiding power), spreading capacity, adhesion and durability. In oil- based paints, organic chemicals such as volatile organic compounds (VOCs) are used as solvents (Khare and Gentner, 2017). These solvents may cause short and long-term environmental hazards (Spurgeon, 2006), and may lead to respiratory, allergic, or immuno-genic reactions in humans. Water-based paints contain water-soluble resins whose individual molecules dissolve completely in water. The resins are usually produced via polycondensation or polymerization reactions in an organic medium, hence they mostly contain organic co-solvents like alcohols, glycol ethers or other oxygen-containing solvents that are soluble or miscible with water. The resins used include vinyl propionate copolymers, vinyl acetate copolymers, acrylate-methacrylate copolymers, and styrene-butadiene copolymers and polymers.

**MATERIALS AND METHOD**

**Sample Collection**

Twelve different in-can water-based paints samples were collected from a specific paint industry in Lagos, Nigeria. Six of the samples were fresh while the other six were spoilt paints showing various evidence of spoilage including foul odor, gassing, discoloration, viscosity loss and separation into phases. Fresh paint samples, with assigned codes in parenthesis, are lilac premium emulsion paint (LPA), grey emulsion paint (GPB), pink premium emulsion paint (PPC), brilliant blue emulsion paint (BPD), off white emulsion paint (OPE) and cream emulsion paint (CPF). Spoilt paint samples (assigned code in parenthesis) include dark brown emulsion paint (DBD), brown emulsion paint (BDA), yellow emulsion paint (YSB), light blue emulsion paint (LBC), light yellow emulsion paint (YSE) and off white paint (OWF). The samples were taken to laboratory and analyzed for their various chemical components with GC-MS.

**Analyte Extraction and Gas Chromatography-Mass SpectrometryAnalysis**

One milliliter of each paint sample was added to 5ml of methanol (HPLC grade) in a falcon tube. Analyte extraction was performed by vortexing for 20 minutes followed by centrifugation at 13,000 rpm for 10 minutes. Clear supernatant (1ml) was aspirated for subsequent GC-MS analysis. The extracted paints samples were analyzed using a GCMS-QP2010 SE (Shimadzu, Japan) with a column Rtx-5MS type. The injection temperature of the column was at 250.00 °C in a split-less mode at a split ratio of 10:1 and a sampling time of 2.00 min. The flow rate of the sample was 1ml/minute of Helium carrier gas. Total flow rate of the sample was 38.7 ml/min with a flow column of 3.22ml/min, a linear velocity of 46.3cm/sec and a purge flow of 3.0ml/min. The ion source and interface temperatures of mass spectrometer detector were at 230oC and 250°C, respectively, while the detector voltage was at 1.2 kV. The scan range of mass-to-charge ratio (m/z) of ion was 45-700. The temperature program started at 60oC for 2 minutes and was increased at the rate of 5oC/min until 120oC was reached. Temperature was ramped at 50oC/min until final temperature of 290oC was reached. Temperature was maintained constantly at 290oC for 2min. The start and end for the MS was set at 5.50min and 22.50min respectively with event time of 0.50seconds at scan speed of 1428 and threshold of 2200 (Wu *et al*., 2015).

**RESULTS**

The results of the total ion chromatograms and tables of GCMS results of spoilt paint samples DBD, BDA, YSB, LBC, YSE and OWF are shown in tables 1-6. Cyclohexane, octane, 3-tetradecene, silane, diethoxydimethoxy, hexadecane, benzene, 2- [tert-butyl-dimethyl-silyl) oxy]-1 and oleic acid were observed in the spoilt paint samples but absent in all fresh paint samples (LPA, GPB, PPC, BPD, OPE and CPF) (tables 7–12). The highest peak at 18.04 minutes corresponding to peak height of 18.28% was obtained for 9-octadecanoic acid (Z)-, methyl ester indicating its abundance in the spoilt paint DBD (table 1). A similar observation is reported for spoilt paints YSB (table 3) and YSE (table 5). In addition, octadecanoic acid 17- methyl esters and 11-octadecanoic acid methyl esters were observed in spoilt paints LBC (table 4) and OWF (table 6), respectively. However, 9-octadecanoic acid (Z)-, methyl ester was detected at a very negligible peak height of 1.12% in fresh paint GPB (table 8). In contrast, 1-propanol, 2-(2-hydroxypropoxy), propanoic acid, 2-methyl-, 2,2-dimethyl-1-, propanoic acid, 2-methyl, 2-ethyl-3-hydro dodecane and propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 tridecane, 1,3-pentanediol, 2,24-trimethyl were observed conspicuously in all the fresh paint samples (tables 7 – 12) but absent in all spoilt paint samples (tables 1 - 6).

Other important compounds present in spoilt paint samples include cyclohexane 2-butyl-1,1,3-trimethyl and methyl 16-methylheptadecanoate. Peaks of 9.14% at 16.5minutes shows that ethanol, 2-[4-(1,1-dimethylethyl)phenoxy] is the most abundant in spoilt paint BDA (table 2). The presence of sulfurous acid, an unstable compound, was observed in spoilt paint OWF (table 6).The presence of low peak (1.08%) of silane diethoxy dimethoxyin spoilt paint BDA (table 2) is indicative of its deteriorative state. This is because the compound is a hydrophobic coating used to shield polar surfaces from interactions with water thus allowing reduction in deterioration at the coating interface of paints and applied surfaces. In spoilt paint LBC (table 4), the retention time of 5.7minutes corresponding to a peak of 8.0% shows the abundant presence of 1,4-dioxan-2-ol which is probably accumulated as a by-product of metabolism and break down of paints components. Carbamic acid was also present in spoilt paints LBC (table 4), YSB (table 5) and BDA (table 2) but absent in all fresh paint samples (tables 7 -12).

Table 1: GCMS results of spoilt Dark brown emulsion paint (DBD)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | R.Time | Area | Area% | Height | Name |
| 1 | 9.673 | 375926 | 4.18 | 131396 | Undecane |
| 2 | 9.862 | 419253 | 4.66 | 117160 | Oxalic acid, isobutyl hexadecyl ester |
| 3 | 10.128 | 689733 | 7.66 | 158439 | Cyclohexane, 2-butyl-1,1,3-trimethyl- |
| 4 | 10.698 | 741020 | 8.23 | 188879 | Octane, 1,1'-oxybis- |
| 5 | 10.898 | 430102 | 4.78 | 130937 | 3-Tetradecene, (E)- |
| 6 | 11.088 | 768016 | 8.53 | 154666 | Oxalic acid, isobutyl hexadecyl ester |
| 7 | 12.031 | 599542 | 6.66 | 208337 | Dodecane, 2,6,10-trimethyl- |
| 8 | 12.243 | 192891 | 2.14 | 85999 | 4-Methyl-dodec-3-en-1-ol |
| 9 | 12.324 | 614378 | 6.83 | 266198 | Hexadecane |
| 10 | 12.938 | 465388 | 5.17 | 178649 | Benzenamine, 3,5-dichloro- |
| 11 | 12.980 | 478772 | 5.32 | 263730 | Dodecane, 2,6,10-trimethyl- |
| 12 | 13.398 | 247534 | 2.75 | 171835 | Tetratetracontane |
| 13 | 14.344 | 309495 | 3.44 | 206425 | Bis(tridecyl) phthalate |
| 14 | 15.213 | 153859 | 1.71 | 60597 | Heptane, 5-ethyl-2-methyl- |
| 15 | 15.351 | 90520 | 1.01 | 71975 | Phenol, 4-(1,1,3,3-tetramethylbutyl)- |
| 16 | 15.408 | 109400 | 1.22 | 76334 | Spiro-1-(cyclohex-2-ene)-2'-(5'-oxabicyclo[ |
| 17 | 15.652 | 131675 | 1.46 | 72938 | Dimethylmalonic acid, di(2-methylphenyl) |
| 18 | 15.726 | 115784 | 1.29 | 84216 | Phenol, 4-(1,1,3,3-tetramethylbutyl)- |
| 19 | 16.879 | 495085 | 5.50 | 333057 | Hexadecanoic acid, methyl ester |
| 20 | 18.043 | 1197489 | 13.30 | 716385 | 9-Octadecenoic acid (Z)-, methyl ester |
| 21 | 18.188 | 375980 | 4.18 | 240937 | Heptadecanoic acid, 16-methyl-, methyl ester |
|  |  | 9001842 | 100.00 | 3919089 |  |

Table 2: GCMS result of spoilt brown emulsion paints (BDA)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 6.276 | 1179516 | 8.21 | 179112 | Carbamoyl chloride, phenyl- |
| 2 | 6.597 | 562907 | 3.92 | 172472 | Butane, 1,4-bis(3-phenylureido)- |
| 3 | 8.090 | 333994 | 2.32 | 113897 | Oxalic acid, isobutyl nonyl ester |
| 4 | 8.541 | 267888 | 1.86 | 77176 | 1-Octadecyne |
| 5 | 8.806 | 233340 | 1.62 | 77438 | Cyclohexanone, 2-methyl-5-(1-methylethen |
| 6 | 9.673 | 575207 | 4.00 | 219487 | Oxalic acid, isobutyl nonyl ester |
| 7 | 10.697 | 442635 | 3.08 | 146116 | 2-methyltetracosane |
| 8 | 11.087 | 405181 | 2.82 | 201055 | Undecane |
| 9 | 11.800 | 813586 | 5.66 | 368070 | Carbamic acid, phenyl-, methyl ester |
| 10 | 12.027 | 189907 | 1.32 | 122239 | Dodecane, 2,6,10-trimethyl- |
| 11 | 12.190 | 150321 | 1.05 | 110836 | 11,12-Dibromo-tetradecan-1-ol acetate |
| 12 | 12.321 | 509692 | 3.55 | 257777 | Dodecane |
| 13 | 12.818 | 150003 | 1.04 | 95317 | 11,12-Dibromo-tetradecan-1-ol acetate |
| 14 | 12.934 | 570173 | 3.97 | 240058 | Benzenamine, 3,4-dichloro- |
| 15 | 13.228 | 219156 | 1.53 | 79021 | 11,12-Dibromo-tetradecan-1-ol acetate |
| 16 | 13.397 | 210407 | 1.46 | 140114 | 2-Bromo dodecane |
| 17 | 14.286 | 119178 | 0.83 | 80846 | 2,2,4-Trimethyl-1,3-pentanediol diisobutyr |
| 18 | 14.343 | 208741 | 1.45 | 143611 | Decane, 1-bromo-2-methyl- |
| 19 | 14.528 | 747061 | 5.20 | 445208 | Phenol, 4-(1,1,3,3-tetramethylbutyl)- |
| 20 | 15.195 | 110482 | 0.77 | 52175 | Sulfurous acid, 2-propyl tridecyl ester |
| 21 | 15.813 | 508549 | 3.54 | 176491 | Swep |
| 22 | 15.975 | 102534 | 0.71 | 36018 | Hexane, 2,2,5,5-tetramethyl- |
| 23 | 16.547 | 993170 | 6.91 | 625197 | Ethanol, 2-[4-(1,1-dimethylethyl)phenoxy]- |
| 24 | 16.878 | 322217 | 2.24 | 212403 | Hexadecanoic acid, methyl ester |
| 25 | 17.110 | 98919 | 0.69 | 73845 | Silane, diethoxydimethoxy- |
| 26 | 17.194 | 309282 | 2.15 | 172486 | Ethanol, 2-[4-(1,1-dimethylethyl)phenoxy]- |
| 27 | 17.248 | 442782 | 3.08 | 160186 | Ethanol, 2-[2-(4-nonylphenoxy)ethoxy]- |
| 28 | 17.326 | 261905 | 1.82 | 165144 | Ethanol, 2-[2-(4-nonylphenoxy)ethoxy]- |
| 29 | 17.536 | 417896 | 2.91 | 235040 | Ethanol, 2-[4-(1,1-dimethylethyl)phenoxy]- |
| 30 | 17.608 | 277560 | 1.93 | 192032 | Propiophenone, 3'-(trimethylsiloxy)- |
| 31 | 18.042 | 376026 | 2.62 | 276722 | 7-Hexadecenoic acid, methyl ester, (Z)- |
| 32 | 18.186 | 212144 | 1.48 | 143395 | Tetradecanoic acid, 12-methyl-, methyl este |
| 33 | 18.468 | 291028 | 2.03 | 189466 | Ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl)p |
| 34 | 19.214 | 368161 | 2.56 | 137484 | 8,14-Seco-3,19-epoxyandrostane-8,14-dion |
| 35 | 21.007 | 239241 | 1.67 | 116319 | Benzene, 2-[(tert-butyldimethylsilyl)oxy]-1 |
| 36 | 21.450 | 244923 | 1.70 | 115410 | Benzene, 2-[(tert-butyldimethylsilyl)oxy]-1 |
| 37 | 21.523 | 276618 | 1.93 | 134732 | i-Propyl 9-tetradecenoate |
| 38 | 21.874 | 624147 | 4.34 | 354414 | Di-n-decylsulfone |
|  |  | 14366477 | 100.00 | 6838809 |  |

Table 3: GCMS result of spoilt yellow emulsion paint (YSB)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 5.712 | 116920 | 1.40 | 43146 | Ethanol, 2-methoxy-, acetate |
| 2 | 6.296 | 552134 | 6.63 | 99315 | 1H-Benzotriazole |
| 3 | 6.608 | 258020 | 3.10 | 91305 | Pyridine, 3-methyl- |
| 4 | 8.091 | 194698 | 2.34 | 53212 | Butane, 2,2-dimethyl- |
| 5 | 9.674 | 200721 | 2.41 | 78155 | Oxalic acid, isobutyl nonyl ester |
| 6 | 10.700 | 201478 | 2.42 | 88908 | Octane, 1,1'-oxybis- |
| 7 | 11.089 | 149365 | 1.79 | 75676 | Oxalic acid, isobutyl nonyl ester |
| 8 | 11.796 | 1732304 | 20.80 | 444283 | Carbamic acid, phenyl-, methyl ester |
| 9 | 12.028 | 198077 | 2.38 | 97789 | Decane, 2,3,5,8-tetramethyl- |
| 10 | 12.322 | 302193 | 3.63 | 161944 | Undecane |
| 11 | 12.821 | 89150 | 1.07 | 53406 | 1H-Indene, octahydro-2,2,4,4,7,7-hexameth |
| 12 | 12.978 | 91744 | 1.10 | 57855 | Oxalic acid, 2-ethylhexyl hexyl ester |
| 13 | 13.228 | 86644 | 1.04 | 45570 | 11,12-Dibromo-tetradecan-1-ol acetate |
| 14 | 13.394 | 112049 | 1.35 | 57654 | 1-Pentanol, 4-methyl-2-propyl- |
| 15 | 13.557 | 50958 | 0.61 | 41323 | 4-Fluoro-2-trifluoromethylbenzoic acid, 2,3 |
| 16 | 14.345 | 181640 | 2.18 | 109361 | Phthalic acid, bis (7-methyloctyl) ester |
| 17 | 14.537 | 82721 | 0.99 | 31796 | 4,6-Bis(4-ethoxybenzylthio)-5-nitropyrimid |
| 18 | 16.878 | 306839 | 3.68 | 198059 | Hexadecanoic acid, methyl ester |
| 19 | 18.042 | 562507 | 6.75 | 323195 | 9-Octadecenoic acid (Z)-, methyl ester |
| 20 | 18.187 | 194981 | 2.34 | 126171 | Heptadecanoic acid, 10-methyl-, methyl ester |
| 21 | 21.440 | 2289713 | 27.49 | 916601 | 3,5-Pyridinedicarbonitrile, 2,6-dimethyl- |
| 22 | 21.815 | 373691 | 4.49 | 128619 | Benzene, 2-[(tertbutyldimethylsilyl)oxy]-1 |
|  |   | 8328547 | 100.00 | 3323343 |  |

Table: 4: GCMS of spoilt light blue emulsion paint (LBC)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 5.751 | 1138920 | 6.40 | 569845 | 1,4-Dioxan-2-ol |
| 2 | 6.615 | 748694 | 4.21 | 180172 | Ethanol, 2-(2-chloroethoxy)- |
| 3 | 8.533 | 323362 | 1.82 | 93208 | Oxirane, tetradecyl- |
| 4 | 8.798 | 180905 | 1.02 | 67304 | trans-Decalin, 2-methyl- |
| 5 | 9.414 | 109552 | 0.62 | 47386 | Tetradecanal |
| 6 | 9.667 | 218436 | 1.23 | 95809 | Decane, 2,3,5,8-tetramethyl- |
| 7 | 9.729 | 2414835 | 13.58 | 468993 | Triethylene glycol |
| 8 | 10.124 | 376212 | 2.12 | 117609 | Dodecane, 1-methoxy- |
| 9 | 10.299 | 1702382 | 9.57 | 249029 | Triethylene glycol |
| 10 | 10.693 | 384612 | 2.16 | 114263 | Methoxyacetic acid, 2-tridecyl ester |
| 11 | 11.086 | 268501 | 1.51 | 106694 | Methoxyacetic acid, 2-tridecyl ester |
| 12 | 11.742 | 633665 | 3.56 | 287227 | Benzenamine, 2,3-dichloro- |
| 13 | 11.785 | 1286645 | 7.23 | 453738 | Carbamic acid, phenyl-, methyl ester |
| 14 | 11.839 | 147982 | 0.83 | 107144 | Cyclohexane, (2-ethyl-1-methyl-1-butenyl)- |
| 15 | 12.116 | 341459 | 1.92 | 140159 | 2-Nonyl-1-ol, diethyl acetal |
| 16 | 12.321 | 252290 | 1.42 | 115535 | Octane, 2,3,3-trimethyl- |
| 17 | 12.460 | 268236 | 1.51 | 64240 | Hexadecane, 1,16-dichloro- |
| 18 | 12.817 | 102184 | 0.57 | 70690 | 1-(2-Hydroxyethyl)-1,2,5,5-tetramethyl-cis- |
| 19 | 12.984 | 204057 | 1.15 | 66182 | Methoxyacetic acid, 2-tetradecyl ester |
| 20 | 13.137 | 524220 | 2.95 | 133855 | 1-Propanol, 2-(1-methylethoxy)- |
| 21 | 13.554 | 144865 | 0.81 | 76565 | Tetraethylene glycol |
| 22 | 13.772 | 107944 | 0.61 | 76877 | 4-Benzyloxy-2-methoxymethoxy-phenol |
| 23 | 13.868 | 79483 | 0.45 | 68004 | Benzene, [(ethoxymethoxy)methyl]- |
| 24 | 14.027 | 713922 | 4.01 | 302644 | Benzenamine, 3,4,5-trichloro- |
| 25 | 14.099 | 117939 | 0.66 | 77166 | 1,3-Dioxolane, 2-methyl- |
| 26 | 14.341 | 111152 | 0.62 | 82331 | 2-((2-Butoxyethoxy)carbonyl)benzoic acid |
| 27 | 14.528 | 261713 | 1.47 | 206006 | Phenol, 4-(1,1,3,3-tetramethylbutyl)- |
| 28 | 14.633 | 159852 | 0.90 | 112417 | Benzene, (1-pentylhexyl)- |
| 29 | 14.670 | 285528 | 1.61 | 214133 | Benzene, (1-butylheptyl)- |
| 30 | 14.768 | 152207 | 0.86 | 128277 | Benzene, (1-propyloctyl)- |
| 31 | 14.964 | 247581 | 1.39 | 63800 | Diethyl carbonate |
| 32 | 15.285 | 50802 | 0.29 | 50327 | Phenyl-tert-butyl-isopropoxyborane |
| 33 | 15.451 | 243521 | 1.37 | 201303 | Benzene, (1-pentylheptyl)- |
| 34 | 15.490 | 219621 | 1.23 | 180313 | Benzene, (1-butyloctyl)- |
| 35 | 15.598 | 104477 | 0.59 | 73476 | Benzene, (1-propylnonyl)- |
| 36 | 15.816 | 86376 | 0.49 | 62711 | Swep |
| 37 | 16.202 | 296579 | 1.67 | 162713 | Benzene, (1-pentyloctyl)- |
| 38 | 16.256 | 134302 | 0.76 | 100566 | Benzene, (1-butylnonyl)- |
| 39 | 16.547 | 128612 | 0.72 | 94002 | Ethanol, 2-[4-(1,1-dimethylethyl)phenoxy]- |
| 40 | 16.876 | 250184 | 1.41 | 192388 | Octadecanoic acid, 17-methyl-, methyl este |
| 41 | 17.444 | 161875 | 0.91 | 67151 | Propiophenone, 3'-(trimethylsiloxy)- |
| 42 | 17.537 | 141959 | 0.80 | 68039 | Ethanol, 2-[4-(1,1-dimethylethyl)phenoxy]- |
| 43 | 17.610 | 109570 | 0.62 | 63385 | 3-Trimethylsilyloxybenzoic anhydride |
| 44 | 18.041 | 198486 | 1.12 | 178053 | 7-Hexadecenoic acid, methyl ester, (Z)- |
| 45 | 18.075 | 154978 | 0.87 | 126953 | 7-Hexadecenoic acid, methyl ester, (Z)- |
| 46 | 18.186 | 144161 | 0.81 | 116920 | Eicosanoic acid, methyl ester |
| 47 | 18.733 | 109665 | 0.62 | 85848 | 8-Dodecenoic acid, 11-hydroxy-, methyl ester |
| 48 | 20.500 | 434649 | 2.44 | 118835 | Benzene, 1-(1,1-dimethylethyl)-4-(2-ethoxy |
| 49 | 20.855 | 486048 | 2.73 | 87222 | (5-Isopropyl-2-methylphenoxy)trimethylsil |
| 50 | 21.821 | 319502 | 1.80 | 111225 | Benzene, 2-[(tert-butyldimethylsilyl)oxy]-1 |
|  |  | 17784702 | 100.00 | 7098732 |  |

Table 5: GCMS result of spoilt light yellow Emulsion Paint (YSE)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak  | R. time | Area  | Area% | Height  | Name |
| 1 | 16.908 | 57542074 | 8.16 | 48412739 | Hexadecanoic acid, methyl ester |
| 2 | 17.218 | 56222783 | 7.97 | 16389927 | n-Hexadecanoic acid |
| 3 | 18.042 | 78447683 | 11.12 | 48681830 | 9,12-Octadecadienoic acid (Z,Z)-, methyl e |
| 4 | 18.090 | 186631277 | 26.46 | 97940611 | 9-Octadecenoic acid, methyl ester, (E)- |
| 5 | 18.214 | 27930185 | 3.96 | 20260369 | Methyl stearate |
| 6 | 18.397 | 151204641 | 21.44 | 35209471 | cis-Vaccenic acid |
| 7 | 18.497 | 22054625 | 3.13 | 7374240 | Oleic Acid |
| 8 | 18.606 | 20088720 | 2.85 | 7096488 | 9,12-Octadecadienoic acid (Z,Z)-, methyl e |
| 9 | 19.251 | 10213868 | 1.45 | 4056125 | cis-13-Eicosenoic acid |
| 10 | 19.397 | 6999810 | 0.99 | 5158580 | Methyl 18-methylnonadecanoate |
| 11 | 20.000 | 2480749 | 0.35 | 849769 | 13-Tetradecenal |
| 12 | 20.306 | 21296324 | 3.02 | 8111079 | cis-9-Hexadecenal |
| 13 | 20.442 | 3498014 | 0.50 | 1518772 | 9-Octadecenal, (Z)- |
| 14 | 20.581 | 13726324 | 1.95 | 6440568 | Tetradecanoic acid, 12-methyl-, methyl este |
| 15 | 21.845 | 32375314 | 4.59 | 9444358 | 9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hyd |
| 16 | 21.979 | 14647907 | 2.08 | 6268604 | Tetracosanoic acid, methyl ester |
|  |  | 705360298 | 100.00 | 323213530 |  |

Table 6: GCMS result of spoilt off white emulsion paint (OWF)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 5.720 | 1191680 | 7.90 | 512119 | Ethanol, 2-methoxy-, acetate |
| 2 | 6.658 | 566534 | 3.76 | 128313 | Ethanol, 2,2'-oxybis- |
| 3 | 8.090 | 237443 | 1.57 | 77797 | Oxalic acid, isobutyl nonyl ester |
| 4 | 8.540 | 238615 | 1.58 | 71880 | Pentadecanal- |
| 5 | 8.802 | 200732 | 1.33 | 76416 | cis-9-Tetradecen-1-ol |
| 6 | 9.672 | 403898 | 2.68 | 171139 | Oxalic acid, isobutyl nonyl ester |
| 7 | 9.736 | 2273879 | 15.08 | 439234 | Triethylene glycol |
| 8 | 10.308 | 598705 | 3.97 | 165983 | Ethanol, 2-[2-(ethenyloxy)ethoxy]- |
| 9 | 10.476 | 2619001 | 17.37 | 360690 | Methenamine |
| 10 | 10.698 | 1284883 | 8.52 | 201488 | Methoxyacetic acid, 2-tridecyl ester |
| 11 | 11.089 | 541954 | 3.59 | 224059 | Sulfurous acid, butyl decyl ester |
| 12 | 12.029 | 253829 | 1.68 | 116500 | Methoxyacetic acid, 2-tridecyl ester |
| 13 | 12.109 | 389164 | 2.58 | 94176 | 2-Heptanol, 6-methyl- |
| 14 | 12.192 | 257443 | 1.71 | 134918 | 1-(2-Hydroxyethyl)-1,2,5,5-tetramethyl-cis- |
| 15 | 12.323 | 580672 | 3.85 | 235944 | Dodecane |
| 16 | 13.185 | 730286 | 4.84 | 135175 | Hexane, 1,2,3-trimethoxy- |
| 17 | 13.396 | 288698 | 1.91 | 86404 | Carbonic acid, butyl 2-pentyl ester |
| 18 | 14.344 | 167837 | 1.11 | 123356 | 2-((2-Butoxyethoxy)carbonyl)benzoic acid |
| 19 | 16.880 | 495568 | 3.29 | 368381 | Hexadecanoic acid, methyl ester |
| 20 | 18.009 | 144561 | 0.96 | 115603 | Cyclopropaneoctanoic acid, 2-[[2-[(2-ethyl |
| 21 | 18.043 | 1110914 | 7.37 | 621985 | 11-Octadecenoic acid, methyl ester |
| 22 | 18.076 | 162048 | 1.07 | 141061 | 10-Octadecenoic acid, methyl ester |
| 23 | 18.189 | 341006 | 2.26 | 243139 | Methyl stearate |
|  |  | 15079350 | 100.00 | 4845760 |  |

Table 7: GCMS result of fresh Lilac emulsion paint (LPA)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 7.137 | 2821641 | 1.58 | 670412 | 2-Propanol, 1,1'-oxybis- |
| 2 | 7.392 | 1500444 | 0.84 | 475610 | 1-Propanol, 2-(2-hydroxypropoxy)- |
| 3 | 7.446 | 2602092 | 1.46 | 518563 | 2-Butanol, 3,3'-oxybis- |
| 4 | 8.089 | 933356 | 0.52 | 284662 | Undecane |
| 5 | 9.166 | 29341715 | 16.47 | 9645601 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 6 | 9.672 | 1418714 | 0.80 | 545876 | Dodecane |
| 7 | 10.475 | 24440960 | 13.72 | 4259835 | Methenamine |
| 8 | 10.927 | 1084428 | 0.61 | 318623 | 1,3-Propanediol, 2-ethyl-2-(hydroxymethyl |
| 9 | 11.087 | 1289308 | 0.72 | 612132 | Dodecane |
| 10 | 11.867 | 33180703 | 18.62 | 17431968 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-( |
| 11 | 12.138 | 49692516 | 27.89 | 25469636 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 12 | 12.321 | 983186 | 0.55 | 583108 | Tridecane |
| 13 | 12.879 | 9396586 | 5.27 | 3018797 | Benzenamine, 2,4-dichloro- |
| 14 | 13.395 | 572699 | 0.32 | 354226 | Dodecane |
| 15 | 13.568 | 662502 | 0.37 | 287685 | Ethanol, 2-(dodecyloxy)- |
| 16 | 14.288 | 3022922 | 1.70 | 2133037 | Propanoic acid, 2-methyl-, 1-(1,1-dimethyle |
| 17 | 14.342 | 355135 | 0.20 | 301322 | 2-Bromo dodecane |
| 18 | 15.781 | 6017311 | 3.38 | 2844962 | Swep |
| 19 | 15.937 | 1014279 | 0.57 | 505480 | Diethylene glycol monododecyl ether |
| 20 | 16.473 | 4076637 | 2.29 | 2282487 | 3(2H)-Isothiazolone, 2-octyl- |
| 21 | 16.877 | 220079 | 0.12 | 196745 | Octadecanoic acid, 17-methyl-, methyl este |
| 22 | 17.841 | 869039 | 0.49 | 542882 | Triethylene glycol monododecyl ether |
| 23 | 18.041 | 627722 | 0.35 | 316764 | 9-Octadecenoic acid (Z)-, methyl ester |
| 24 | 19.484 | 906810 | 0.51 | 509920 | Tetraethylene glycol monododecyl ether |
| 25 | 21.159 | 1171073 | 0.66 | 348841 | Octaethylene glycol monododecyl ether |
|  |  | 178201857 | 100.00 | 74459174 |  |

Table 8: GCMS of fresh Grey emulsion paint (GPB)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 7.126 | 2050577 | 1.22 | 591261 | 2-Propanol, 1,1'-oxybis- |
| 2 | 7.384 | 1090391 | 0.65 | 400485 | 1-Propanol, 2-(2-hydroxypropoxy)- |
| 3 | 7.440 | 1851526 | 1.10 | 440372 | 1-Propanol, 2-(2-hydroxypropoxy)- |
| 4 | 9.144 | 8390605 | 5.01 | 3648171 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 5 | 9.675 | 484708 | 0.29 | 242095 | Dodecane |
| 6 | 10.425 | 11483750 | 6.85 | 6115102 | Methenamine |
| 7 | 10.920 | 3994811 | 2.38 | 1248049 | 1,3-Propanediol, 2-ethyl-2-(hydroxymethyl |
| 8 | 11.543 | 4192688 | 2.50 | 421107 | Propanoic acid, 2-methyl-, 2-ethyl-3-hydro |
| 9 | 11.799 | 4325623 | 2.58 | 1120725 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 10 | 11.873 | 43372062 | 25.88 | 21150456 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-( |
| 11 | 12.146 | 64111194 | 38.26 | 28489489 | Propanoic acid, 2-methyl-, 2-ethyl-3-hydro |
| 12 | 12.323 | 662871 | 0.40 | 349538 | Dodecane |
| 13 | 12.462 | 209813 | 0.13 | 80361 | 2,4,7,9-Tetramethyl-5-decyn-4,7-diol |
| 14 | 12.881 | 8060810 | 4.81 | 3160295 | Benzenamine, 2,4-dichloro- |
| 15 | 13.397 | 246037 | 0.15 | 171036 | Tridecane |
| 16 | 14.290 | 428769 | 0.26 | 347023 | Propanoic acid, 2-methyl-, 1-(1,1-dimethyle |
| 17 | 14.343 | 217279 | 0.13 | 186153 | Decane, 1-bromo-2-methyl- |
| 18 | 15.786 | 4075743 | 2.43 | 1808598 | Swep |
| 19 | 16.476 | 4003924 | 2.39 | 2046497 | 3(2H)-Isothiazolone, 2-octyl- |
| 20 | 16.879 | 843134 | 0.50 | 530276 | Hexadecanoic acid, methyl ester |
| 21 | 18.043 | 1875044 | 1.12 | 933409 | 9-Octadecenoic acid (Z)-, methyl ester |
| 22 | 18.190 | 347943 | 0.21 | 296435 | Methyl stearate |
| 23 | 21.527 | 441731 | 0.26 | 226886 | 1,3-Dioxolane, 4-ethyl-5-octyl-2,2-bis(trifl |
| 24 | 21.879 | 819516 | 0.49 | 395505 | Di-n-decylsulfone |
|  |  | 167580549 | 100.00 | 74399324 |  |

Table 9: GCMS result of fresh pink emulsion pain (PPC)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Name |
| 1 | 7.145 | 1946613 | 1.11 | 543273 | 2-Propanol, 1,1'-oxybis- |
| 2 | 7.401 | 892662 | 0.51 | 344745 | 1-Propanol, 2-(2-hydroxypropoxy)- |
| 3 | 7.458 | 1588871 | 0.91 | 370525 | 1-Propanol, 2-(2-hydroxypropoxy)- |
| 4 | 8.088 | 419117 | 0.24 | 143218 | Oxalic acid, isobutyl nonyl ester |
| 5 | 9.167 | 21762327 | 12.40 | 8823919 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 6 | 9.674 | 435185 | 0.25 | 247956 | Dodecane |
| 7 | 9.859 | 178156 | 0.10 | 102806 | Undecane, 3,6-dimethyl- |
| 8 | 10.433 | 38425794 | 21.90 | 6436509 | Methenamine |
| 9 | 10.783 | 311952 | 0.18 | 189289 | 1-Decanol |
| 10 | 11.089 | 719026 | 0.41 | 271552 | Tridecane |
| 11 | 11.867 | 30039072 | 17.12 | 16857055 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-( |
| 12 | 12.138 | 48271728 | 27.51 | 25004050 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 13 | 12.879 | 10223026 | 5.83 | 3239795 | Benzenamine, 2,4-dichloro- |
| 14 | 13.570 | 376865 | 0.21 | 221146 | Ethanol, 2-(dodecyloxy)- |
| 15 | 14.289 | 4962073 | 2.83 | 3813983 | Propanoic acid, 2-methyl-, 1-(1,1-dimethyle |
| 16 | 15.781 | 6191916 | 3.53 | 2913569 | Swep |
| 17 | 15.938 | 829530 | 0.47 | 410565 | Diethylene glycol monododecyl ether |
| 18 | 16.473 | 4342719 | 2.47 | 2374643 | 3(2H)-Isothiazolone, 2-octyl- |
| 19 | 16.876 | 313448 | 0.18 | 246802 | Octadecanoic acid, 17-methyl-, methyl este |
| 20 | 17.842 | 696978 | 0.40 | 385844 | Triethylene glycol monododecyl ether |
| 21 | 18.041 | 705363 | 0.40 | 377708 | 7-Octadecenoic acid, methyl ester |
| 22 | 19.486 | 773069 | 0.44 | 365008 | Octaethylene glycol monododecyl ether |
| 23 | 21.163 | 678167 | 0.39 | 207413 | Octaethylene glycol monododecyl ether |
| 24 | 21.876 | 390875 | 0.22 | 202682 | Di-n-decylsulfone |
|  |  | 175474532 | 100.00 | 74094055 |  |

Table 10: GCMS result of fresh Brilliant blue emulsion paint (BPD)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Height% | A/H | Name |
| 1 | 7.150 | 4696798 | 1.76 | 1014566 | 0.93 | 4.63 | 2-Propanol, 1,1'-oxybis- |
| 2 | 8.091 | 2459516 | 0.92 | 866470 | 0.80 | 2.84 | Tridecane, 6-methyl- |
| 3 | 9.196 | 47899766 | 17.96 | 13647270 | 12.57 | 3.48 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 4 | 9.675 | 3758299 | 1.41 | 1844161 | 1.70 | 2.04 | Dodecane |
| 5 | 10.232 | 8384674 | 3.14 | 2141219 | 1.97 | 3.92 | Triethylene glycol |
| 6 | 10.439 | 25104500 | 9.41 | 6596828 | 6.07 | 3.81 | Methenamine |
| 7 | 11.089 | 4416556 | 1.66 | 2025828 | 1.87 | 2.18 | Dodecane |
| 8 | 11.866 | 30081078 | 11.28 | 16098654 | 14.82 | 1.87 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-( |
| 9 | 12.134 | 45213879 | 16.96 | 23531323 | 21.67 | 1.92 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 10 | 12.322 | 3159630 | 1.18 | 1841240 | 1.70 | 1.72 | Dodecane |
| 11 | 12.885 | 6078208 | 2.28 | 2273312 | 2.09 | 2.67 | Benzenamine, 3,4-dichloro- |
| 12 | 13.396 | 2241168 | 0.84 | 1137053 | 1.05 | 1.97 | Pentadecane |
| 13 | 13.492 | 18718075 | 7.02 | 9019515 | 8.31 | 2.08 | Tetraethylene glycol |
| 14 | 13.567 | 3473717 | 1.30 | 1110324 | 1.02 | 3.13 | Pentaethylene glycol monododecyl ether |
| 15 | 14.288 | 3772011 | 1.41 | 2248833 | 2.07 | 1.68 | Pentanoic acid, 2,2,4-trimethyl-3-carboxyis |
| 16 | 14.341 | 1027981 | 0.39 | 785891 | 0.72 | 1.31 | Hexadecane |
| 17 | 14.741 | 359397 | 0.13 | 204973 | 0.19 | 1.75 | Pentadecane, 2,6,10-trimethyl- |
| 18 | 15.193 | 678589 | 0.25 | 299181 | 0.28 | 2.27 | Heptadecane, 2,6,10,15-tetramethyl- |
| 19 | 15.782 | 3541605 | 1.33 | 2225881 | 2.05 | 1.59 | Swep |
| 20 | 15.918 | 19913175 | 7.47 | 8483438 | 7.81 | 2.35 | Pentaethylene glycol |
| 21 | 16.470 | 3038179 | 1.14 | 1961789 | 1.81 | 1.55 | 3(2H)-Isothiazolone, 2-octyl- |
| 22 | 17.837 | 1192874 | 0.45 | 800152 | 0.74 | 1.49 | Triethylene glycol monododecyl ether |
| 23 | 17.883 | 11601889 | 4.35 | 3698045 | 3.41 | 3.14 | Hexaethylene glycol |
| 24 | 19.479 | 1313583 | 0.49 | 821695 | 0.76 | 1.60 | Tetraethylene glycol monododecyl ether |
| 25 | 19.570 | 7721560 | 2.90 | 2313076 | 2.13 | 3.34 | Heptaethylene glycol |
| 26 | 21.152 | 1278873 | 0.48 | 589035 | 0.54 | 2.17 | Octaethylene glycol monododecyl ether |
| 27 | 21.312 | 5535800 | 2.08 | 1013587 | 0.93 | 5.46 | Heptaethylene glycol |
|  |  | 266661380 | 100.00 | 108593339 | 100.00 |  |  |

Table 11: GCMS result of fresh off white emulsion paint (OPE)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Height% | Name |
| 1 | 6.644 | 2590822 | 1.28 | 529587 | 0.66 | Trichloroacetic acid, 2-ethylhexyl ester |
| 2 | 7.144 | 4423828 | 2.18 | 915945 | 1.14 | 2-Propanol, 1,1'-oxybis- |
| 3 | 7.454 | 2779313 | 1.37 | 732887 | 0.91 | 2-Butanol, 3,3'-oxybis- |
| 4 | 8.094 | 3380648 | 1.67 | 893457 | 1.11 | Undecane |
| 5 | 8.556 | 3105008 | 1.53 | 748397 | 0.93 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 6 | 9.191 | 47758650 | 23.53 | 12990768 | 16.17 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 7 | 9.675 | 4688094 | 2.31 | 1472108 | 1.83 | Dodecane |
| 8 | 10.435 | 15419001 | 7.60 | 8933359 | 11.12 | Methenamine |
| 9 | 10.531 | 8691313 | 4.28 | 1661074 | 2.07 | Methenamine |
| 10 | 10.700 | 2298115 | 1.13 | 778700 | 0.97 | Pentadecane, 7-methyl- |
| 11 | 10.917 | 3653956 | 1.80 | 748324 | 0.93 | 1,3-Propanediol, 2-ethyl-2-(hydroxymethyl |
| 12 | 11.090 | 4113168 | 2.03 | 1642935 | 2.05 | Tridecane |
| 13 | 11.762 | 6411494 | 3.16 | 937096 | 1.17 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 14 | 11.866 | 30426347 | 14.99 | 15670172 | 19.51 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-( |
| 15 | 12.135 | 42664295 | 21.02 | 22593812 | 28.13 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 16 | 12.323 | 2714334 | 1.34 | 1503625 | 1.87 | Dodecane |
| 17 | 12.888 | 4932412 | 2.43 | 1528846 | 1.90 | Benzenamine, 3,4-dichloro- |
| 18 | 13.398 | 2130523 | 1.05 | 995469 | 1.24 | Pentadecane |
| 19 | 14.344 | 915255 | 0.45 | 601231 | 0.75 | Hexadecane |
| 20 | 15.793 | 2852179 | 1.41 | 1151539 | 1.43 | Swep |
| 21 | 15.942 | 954921 | 0.47 | 481118 | 0.60 | Diethylene glycol monododecyl ether |
| 22 | 16.482 | 2321932 | 1.14 | 1074354 | 1.34 | 3(2H)-Isothiazolone, 2-octyl- |
| 23 | 16.881 | 346810 | 0.17 | 260448 | 0.32 | Hexadecanoic acid, methyl ester |
| 24 | 17.848 | 786619 | 0.39 | 392559 | 0.49 | Triethylene glycol monododecyl ether |
| 25 | 18.043 | 963922 | 0.48 | 503049 | 0.63 | 9-Octadecenoic acid, methyl ester, (E)- |
| 26 | 19.493 | 1038953 | 0.51 | 395266 | 0.49 | Tetraethylene glycol monododecyl ether |
| 27 | 21.171 | 564812 | 0.28 | 189941 | 0.24 | Heptaethylene glycol monododecyl ether |
|  |  | 202926724 | 100.00 | 80326066 | 100.00 |  |

Table 12: GCMS of fresh cream emulsion paint (CPF)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Peak | R.Time | Area | Area% | Height | Height% | A/H | Name |
| 1 | 7.158 | 4289667 | 2.09 | 941374 | 1.15 | 4.56 | 2-Propanol, 1,1'-oxybis- |
| 2 | 7.465 | 2166397 | 1.06 | 704707 | 0.86 | 3.07 | 2-Butanol, 3,3'-oxybis- |
| 3 | 8.094 | 3217018 | 1.57 | 833277 | 1.02 | 3.86 | Undecane |
| 4 | 8.758 | 3261335 | 1.59 | 971871 | 1.19 | 3.36 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 5 | 9.200 | 52829481 | 25.77 | 14094800 | 17.21 | 3.75 | 1,3-Pentanediol, 2,2,4-trimethyl- |
| 6 | 9.677 | 3370122 | 1.64 | 1493678 | 1.82 | 2.26 | Dodecane |
| 7 | 9.865 | 1314428 | 0.64 | 629813 | 0.77 | 2.09 | Undecane, 2,6-dimethyl- |
| 8 | 10.440 | 11838023 | 5.77 | 6819505 | 8.33 | 1.74 | Methenamine |
| 9 | 10.528 | 13150192 | 6.41 | 2529291 | 3.09 | 5.20 | Methenamine |
| 10 | 10.701 | 1816957 | 0.89 | 744692 | 0.91 | 2.44 | Pentadecane, 7-methyl- |
| 11 | 10.923 | 3200611 | 1.56 | 689778 | 0.84 | 4.64 | 1,3-Propanediol, 2-ethyl-2-(hydroxymethyl |
| 12 | 11.092 | 3805160 | 1.86 | 1647867 | 2.01 | 2.31 | Dodecane |
| 13 | 11.871 | 31816735 | 15.52 | 15083895 | 18.42 | 2.11 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-( |
| 14 | 12.139 | 46650847 | 22.75 | 24468361 | 29.88 | 1.91 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 |
| 15 | 12.325 | 2650295 | 1.29 | 1548143 | 1.89 | 1.71 | Dodecane |
| 16 | 12.891 | 4879187 | 2.38 | 1614550 | 1.97 | 3.02 | Benzenamine, 2,4-dichloro- |
| 17 | 13.399 | 1412005 | 0.69 | 1011843 | 1.24 | 1.40 | Hexadecane |
| 18 | 13.575 | 771283 | 0.38 | 290068 | 0.35 | 2.66 | Ethanol, 2-(dodecyloxy)- |
| 19 | 14.290 | 792042 | 0.39 | 463807 | 0.57 | 1.71 | Pentanoic acid, 2,2,4-trimethyl-3-carboxyis |
| 20 | 14.345 | 742433 | 0.36 | 516693 | 0.63 | 1.44 | Hexadecane |
| 21 | 15.195 | 453291 | 0.22 | 231690 | 0.28 | 1.96 | Heptadecane, 2,6,10,15-tetramethyl- |
| 22 | 15.794 | 3011488 | 1.47 | 1158963 | 1.42 | 2.60 | Swep |
| 23 | 15.942 | 1261060 | 0.62 | 509978 | 0.62 | 2.47 | Diethylene glycol monododecyl ether |
| 24 | 16.482 | 2413536 | 1.18 | 1034352 | 1.26 | 2.33 | 3(2H)-Isothiazolone, 2-octyl- |
| 25 | 16.880 | 364464 | 0.18 | 275348 | 0.34 | 1.32 | Hexadecanoic acid, methyl ester |
| 26 | 17.849 | 854724 | 0.42 | 391295 | 0.48 | 2.18 | Triethylene glycol monododecyl ether |
| 27 | 18.043 | 1045596 | 0.51 | 503210 | 0.61 | 2.08 | 11-Octadecenoic acid, methyl ester |
| 28 | 18.188 | 275498 | 0.13 | 163338 | 0.20 | 1.69 | Eicosanoic acid, methyl ester |
| 29 | 19.493 | 851180 | 0.42 | 335335 | 0.41 | 2.54 | Tetraethylene glycol monododecyl ether |
| 30 | 21.172 | 517005 | 0.25 | 174133 | 0.21 | 2.97 | Octaethylene glycol monododecyl ether |
|  |  | 205022060 | 100.00 | 81875655 | 100.00 |  |  |

**DISCUSSION:** Compositional structure variations of spoilt and fresh paints were analyzed using GC-MS analysis. Previous works have shown that the consequences of paint deterioration such as foul smell, viscosity loss, discoloration and visible surface growth have serious implications on the paint industry (Obidi *et al.* 2009). This is because, over time, the organic and inorganic components of the paints are degraded by microorganisms and used as sources of nutrients for growth and cellular activities (Obidi *et al.* 2009; Okunye, *et al,* 2013).This degradation contributes to the differences observed in the chemical components of the spoilt and fresh paint samples. 1,4-dioxan-2-, 9-octadecanoic acid (Z)-, methylester, 2-[4-(1,1-dimethylethyl)phenoxy,silanediethoxydimethoxy and oleic acid observed in the spoilt samples indicate degradation of paint components. This is in line with the report of Cappitelli *et al.*2007)

in the analysis of paint biodeterioration using FT-IR which revealed the abundance of methyl groups (CH3) and several other aldehydes conjugated with ketonic groups. Similarly, fatty acids were found in substantial amounts in spoilt brown emulsion paint in the present work. This can be attributed to the acrylic resins which are used as binders and are prepared by polymerization of acrylic methacrylic esters. After attack by spoilage microorganisms, there is a change in the polymeric structure of the ester bands by rupturing of ester linkages. Similar results were observed in paint films biodegradation by Dutta *et al.* (2005). Other compounds present in spoilt samples such as cyclohexane 2-butyl-1,1,3-trimethyl and methyl 16-methylheptadecanoate probably occurred as a result of metabolism of the hydrocarbon components of the binders in paints (Abbasian and Lockington, 2015). Sulfurous acid, a very unstable compound, was detected in spoilt off white emulsion paint indicating degradation of sulphate-reducing bacteria. These bacteria were probably introduced into the paint by contamination thus, causing biodeterioration of the paints (Obidi *et al*., 2009). The high prevalence of ethanolic compounds in four of the spoilt paint samples, namely BDA, YSB, LBC and OWF, shows the metabolizing activity of microorganism leading to breakdown of paint components and accumulation of alcohol as end-product of metabolism. The presence of carbamic acid in spoilt paint samples LBC, YSB and BDA and its conspicuous absence in all fresh paint samples suggests hydrolysis of esters in the spoilt paint samples. Carbamic acids are intermediates in the decomposition or hydrolysis of ester bonds which are incorporated into paints to prevent drying (Jager *et al*., 2000). The abundance of alkyl polymers (resins) in fresh paint samples indicates the level of freshness and wholesomeness of the paint compared to the spoilt paint samples. We report peak height of 23.41 and 34.21 in fresh paint samples corresponding to alkyl esters which are important resins acting as binders in paints (Bently, 1997). There is also an abundance of propanoic acid compounds such as propanoic acid, 2-methyl-, 2,2-dimethyl-1 with peak of 23.4 % at retention time of 11.86 minutes and propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 with peak of 34.21% at retention time of 12.1minutes in fresh lilac emulsion paint. Similarly, propanoic acid, 2-methyl-, 3-hydroxy-2,4,4 with peak of 28.43 % and 38.29 % peak for propanoic acid, 2-methyl-, 2-ethyl-3-hydro- were observed in fresh pink emulsion paint. The uniform presence of these propanols in all the fresh paint samples confirm their wholesomeness while their absence in all spoilt paint samples indicate the possibility of microbial degradation. Marcelo *et al.,*2015 also identified similar peaks and compounds for the synthetic resins in Brazilian paintings at different retention times. Similar observations were reported in the work of Ogbulie *et al*. (2004) on the microbial deterioration of surface paint coating. Butyl alcohols in the fresh paint samples are expected as butyl acrylate is a component of resins (Pan and Zhang, 2003). The occurrence of 2,24-trimethyl-1,3-pentanediol in all fresh paint samples and its absence in all spoilt paint samples is indicative of the intact structure of fresh paint samples as they are used as coalescing agents in paint manufacturing process (Corsi and Lin, 2009). Its absence in spoilt paint samples shows degradation and disintegration of binder and could be responsible for the observed loss of viscosity in the spoilt paints. The presence of oxalic acids in both fresh and spoilt samples is not unexpected since they are products of carbohydrate oxidation on exposure of paint to air. They can also be produced from precursors such as ethylene glycol or glycolic acid (Santos *et al*., 2020).

**CONCLUSION:** Our findings show that GC-MS is a versatile tool for the analysis of paint components in quality control assessment. We report marked differences in the chemical composition of fresh and spoilt paints suggesting microbial degradation and contamination of spoilt paints. The effects of such microbial infestation results in disfigurement of the paint followed by breakdown of the binders and other paint components.

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