

C.I.No. Reactive Red 195 가

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Inhalation toxicity assessment of C.I.No. Reactive Red 195 in Rats

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Many reactive dyes have been used in occupational settings without knowing their toxicity and health hazard information. To investigate the toxicity of reactive dye, C.I.No. Reactive Red 195 was exposed to male and female Sprague Dawley rats by inhalation for 28 days. The rats were exposed C.I.No. Reactive Red 195 for 6 hrs per day and 5days per week. The concentrations for the inhalation exposure were 0, 10, 40 and 160 mg/m³. After 4 weeks of exposure, rats were examined for exposure related changes through pathology, blood biochemistry and hematology.

There were no dose related changes including clinical signs, body weight and relative organ weight changes, hematological and biochemical and histopathological findings.

The results indicate that no observed adverse effect level (NOAEL) of 28 days inhalation toxicity test for C.I.No. Reactive Red 195 was 160 mg/m³.

Key Words : C.I.No. Reactive Red 195, Inhalation toxicity, NOAEL

I. MSDS (material safety data sheet) 92, o-toluidine 가, LD₅₀ 50, IARC (International Agency for Research on Cancer) 1, benzidine, o-toluidine, formaldehyde, PCP (Pentachlorophenol), Cr (table1). 가, (, 2000; , 1997). (, 2000) benzidine 4-aminodiphenyl, , ,

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batch system 가 1984), (IARC, 1974) , 13 3,3' -dimethoxybenzidine (DMOB, o-dianisidine) 가 가 가 C.I.No. Reactive Red 195 HEPA filter (Morgan et al., 1989) 가 (Gray et al., 1992; 1993; Ballantyne 2. 1994; Sailstad et al., 1994), 1,200 , 1999 - 7 (Specific Pathogen Free, C.I.No. Reactive Red SPF) Sprague-Dawley (SD) Rats barrier system 2 68,836 , 41,456 , 27,698 , 82,556 . 46,005 (55.7%), 14,760 (17.9%) (disperse dye) 가 가 (reactive dye) (, 1999). , 5 , 10, 40, 160mg/m³ 3 , 4 , 5 Reactive (inhalation chamber) 5 Class (,) (,) 10,000) , 22 ±3 , 30-70 % , 10-12/ , -9 ~ -11 mmAq (,) 12 150 - 300 Lux , () , 2000). C.I.No. Reactive Red 195 (chromophore) (-N=N-) C.I.No. Reactive Red 195 C.I.No. Reactive Red 195 (1119.86, C₃₁H₁₉Cl₁N₇O₁₈.S₆Na₅) C.I.No. Reactive Red 195 3. KX-100, Sodium phosphate anhydrous, Sodium phosphate triphosphate, Sodium sulfate anhydrous 가 , Co., LTD, Japan) 1.16 m³ turn table dust (Nony et al., 1980; Lynn et al., 1980). 가 (free aromatic amine) (Nony et al., 1983), (benzidine congener and derived dyes) 가 Salmonella assay (Prival et al.,

Table 1. Analysis of dye toxicity information on 92 MSDS of 7 companies.

	MSDS	Rat oral LD ₅₀	IARC	Inhalation Toxicity
Reactive	45	22	0	0
Disperse	36	25	0	0
Acid	9	1	1	0
Fluorescent	2	2	0	0
Sum	92	50	1	0

(Model No. DF-3, SIBATA Co., LTD, Japan) dust feeder (Model No. DF-3, SIBATA Co., LTD, Japan)

Table 2. Environmental condition in inhalation chamber during the experiment

	Chamber 0 (Control)	Chamber 1 (10mg/m ³)	Chamber 2 (40mg/m ³)	Chamber 3 (160mg/m ³)
T ()	24.5 ± 1.5	22.8 ± 1.6	22.7 ± 1.7	22.4 ± 1.7
RH (%)	46.2 ± 9.3	46.9 ± 9.7	46.9 ± 9.4	47.8 ± 9.5
P (mmH ₂ O)	-104.6 ± 2.9	-98.2 ± 8.1	-98.0 ± 7.0	-107.7 ± 19.0
R (l/min)	203.2 ± 2.1	200.3 ± 2.2	198.5 ± 2.0	200.2 ± 19.0

T; Temperature, RH; Relative Humidity, P; Pressure, R; Flow Rate
All data values are expressed as total mean (for 4 weeks) ± SD.

10 mg/m³
40mg/m³, 160 mg/m³

6.

1 6 , 5 , 4

(1) 육안 검사

7.

4. monitoring

ethyl ether

(one-way

ANOVA)

Dunnett

P<0.05

monitoring

(2) 혈액 및 혈액생화학검사

(Sysmex F-820, Japan)

(Model No. ICS-800DG, SIBATA Tech. LTD, Japan) 30 1

white blood cell (WBC), red blood cell (RBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platlet (PLT)

1.

(mg/m³) (Gil-Air, Gilian, USA) 37mm

(TBA 20FR, Japan)

4

1.2 /min 40

total protein (TP), blood urea nitrogen (BUN), creatinine (CRTN), total bilirubin (T-BIL), Glucose (GLU), total cholesterol (T-CHO), aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphotase (ALP), lactic dehydrogenase (LDH)

Table 2

198.5-203.2 /min

1,160 (1 m³)

10.27 - 10.51

sampling

size

Anderson sampler (Impactor Serial No. 200913, SIBATA Tech. LTD., Japan) sampling

2.

monitoring

20 , 28.3 L/min

80 mm (T60A20, pallflex

(3) 장기중량 측정 및 병리조직검사

products, co., Japan)

Figure 1

5.

10 %

Table 3

37.99 ~ ±61.48 %

3 %

1

가

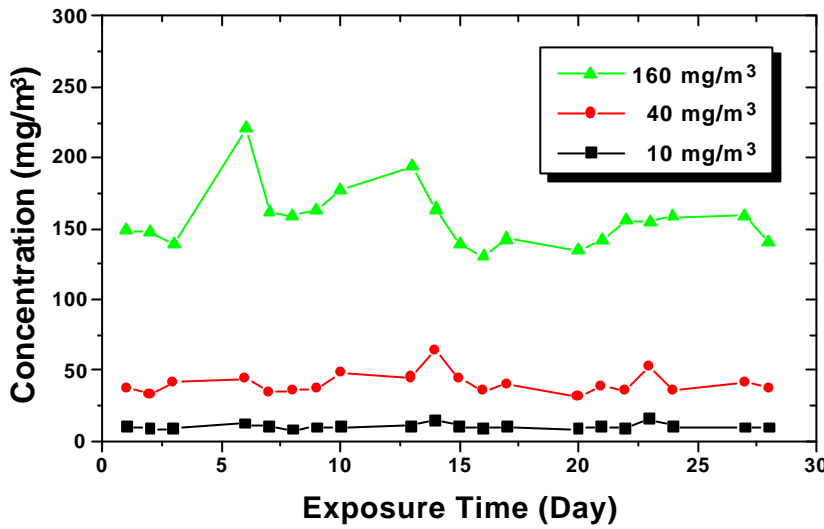


Figure 1. Concentration in inhalation chamber during the exposure of C.I.No. Reactive Red 195 for 4 weeks

Table 3. Concentration of C.I.No. Reactive Red 195 by exposure groups

Groups	Concentration (mg/m³)			
	Establishment	Upper	Lower	Mean ± SD
Control	0	0.0	0.0	0.0 ± 0.00
Group 1	10	16.05	8.22	10.3 ± 1.99
Group 2	40	64.59	30.84	40.6 ± 7.80
Group 3	160	220.78	130.94	156.6 ± 21.38

, Figure 3

2, 3
 10 mg/m³ 2, 3
 40 mg/m³
 (p<0.05), 2, 3
 , 4 160 mg/m³
 (p<0.05)

5.

(1) 장기중량

(relative organ weight)

10 mg/m³
 40 mg/m³

(P<0.05)

(table 5), 160 mg/m³

가

(table 6).

(2) 혈액 및 혈액생화학검사

4.7 μm, 50%
) (respirable particulate
 mass) (table 4).

, Table 7

3.

4.

45.18 % 가 11 μm
 , 54.82 % 가 10 μm

Table 8

11.16 % 가 4.7 μm
 ACGIH (American Conference
 of Governmental Industrial Hygienists)

Figure 2

10mg/m³, 40mg/m³
 (TP)
 (P<0.05)

(ACGIH,

Table 4. Particles size distribution analysis of C.I.No. Reactive Red 195

2000),
 (inhalable particulate mass)
 0 ~ 100 μm (50%)
 , 54.82 %가
 10 μm (50%)
 (thoracic particulate
 mass)
 11.16 %가 4 μm (

Stage No.	Particle size (μm)	Particle weight (mg)	Ratio (%)
0	11.0-	8.02	45.18
1	7.00-11.0	4.52	25.46
2	4.70-7.00	3.23	18.20
3	3.30-4.70	1.50	8.45
4	2.10-3.30	0.36	2.03
5	1.10-2.10	0.11	0.62
6	0.65-1.10	0.01	0.06
7	0.43-0.65	0.00	0.00
8	-0.43	0.00	0.00

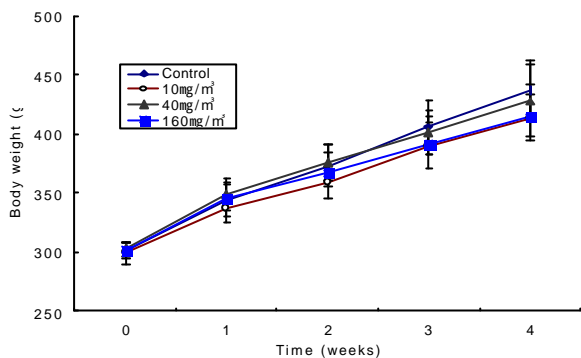


Figure 2 Changes of body weight of male SD rats inhaled C.I.No. Reactive Red 195 for 4 weeks

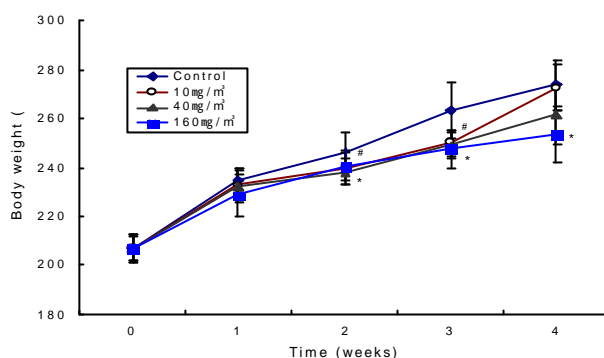


Figure 3 Changes of body weight of female SD rats inhaled C.I.No. Reactive Red 195 for 4 weeks
#: 10mg/m³, : 40mg/m³, *: 160mg/m³, p<0.05 versus control

Table 5. Relative organ weights of male SD rats inhaled C.I.No. Reactive Red 195 for 4 weeks (Unit : %)

	Control	10mg/m ³	40mg/m ³	160mg/m ³
Body weight (g)	437.7 ± 25.3	414.4 ± 20.4	428.6 ± 30.1	416.0 ± 26.1
Thymus	0.13 ± 0.03	0.11 ± 0.02	0.10 ± 0.01	0.11 ± 0.02
Adrenal R	0.01 ± 0.01	0.01 ± 0.00*	0.01 ± 0.00	0.01 ± 0.00
Adrenal L	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
Testis R	0.40 ± 0.04	0.43 ± 0.03	0.39 ± 0.03	0.41 ± 0.03
Testis L	0.40 ± 0.05	0.43 ± 0.02	0.39 ± 0.02	0.42 ± 0.02
Heart	0.30 ± 0.01	0.29 ± 0.02	0.27 ± 0.02	0.29 ± 0.01
Lung R	0.25 ± 0.03	0.25 ± 0.01	0.22 ± 0.02*	0.25 ± 0.02
Lung L	0.13 ± 0.02	0.12 ± 0.00	0.11 ± 0.01	0.12 ± 0.01
Kidney R	0.33 ± 0.02	0.31 ± 0.02	0.30 ± 0.02*	0.35 ± 0.02
Kidney L	0.33 ± 0.02	0.30 ± 0.01	0.29 ± 0.02*	0.34 ± 0.02
Spleen	0.19 ± 0.02	0.17 ± 0.02	0.17 ± 0.01	0.17 ± 0.03
Liver	2.78 ± 0.22	2.19 ± 0.09	2.50 ± 0.13	2.55 ± 0.10
Brain	0.47 ± 0.02	0.52 ± 0.04	0.49 ± 0.03	0.50 ± 0.03

Relative organ weight (%) = (organ weight (g) / Body weight (g)) × 100

All values are expressed as mean ± SD.

Significant differences as compared with control: * p < 0.05

Table 6. Relative organ weights of female SD rats inhaled C.I.No. Reactive Red 195 for 4 weeks (Unit : %)

	Control	10mg/m ³	40mg/m ³	160mg/m ³
Body weight (g)	273.7 ± 10.4	272.4 ± 9.6	261.6 ± 11.9	253.5 ± 11.4
Thymus	0.13 ± 0.02	0.14 ± 0.01	0.14 ± 0.02	0.15 ± 0.01
Adrenal R	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
Adrenal L	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00
Ovary R	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00
Ovary L	0.03 ± 0.00	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.00
Heart	0.32 ± 0.02	0.31 ± 0.02	0.32 ± 0.02	0.34 ± 0.02
Lung R	0.30 ± 0.02	0.30 ± 0.03	0.30 ± 0.02	0.30 ± 0.01
Lung L	0.15 ± 0.01	0.14 ± 0.00	0.15 ± 0.02	0.16 ± 0.01
Kidney R	0.31 ± 0.02	0.31 ± 0.02	0.32 ± 0.02	0.35 ± 0.03
Kidney L	0.30 ± 0.01	0.30 ± 0.03	0.31 ± 0.02	0.33 ± 0.03
Spleen	0.20 ± 0.30	0.20 ± 0.02	0.19 ± 0.02	0.19 ± 0.01
Liver	2.63 ± 0.18	2.59 ± 0.10	2.68 ± 0.13	2.66 ± 0.12
Brain	0.72 ± 0.02	0.72 ± 0.04	0.75 ± 0.04	0.78 ± 0.05

Relative organ weight (%) = (organ weight (g) / Body weight (g)) × 100

All values are expressed as mean ± SD.

Significant differences as compared with control: * p < 0.05

(7.0±0.7)
(田嶋嘉雄, 1989),

(3) 육안 및 조직병리검사

3
2, 3
3 (alveolar cells hyperplasia)

Figure 4
160mg/m³
(macrophage) 가

Table 7. Hematological results in SD rats inhaled C.I.No. Reactive Red 195 for 4 weeks

	Control		10mg/m ³		40mg/m ³		160mg/m ³	
No. of male	5		5		5		5	
WBC	4.4±	1.91	6.3±	2.89	5.0 ±	1.30	6.2 ±	2.07
RBC	7.4±	0.35	7.6±	0.07	7.3 ±	0.32	7.8 ±	0.28
HGB	14.2±	0.45	14.4±	0.25	13.9±	0.60	14.8±	0.76
HCT	41.9±	1.24	42.7±	2.051	40.6±	1.63	43.2±	1.82
MCV	56.6±	1.91	56.2±	0.88	55.7±	1.24	55.2±	1.33
MCH	19.1±	0.36	18.9±	0.30	19.1±	0.58	18.9±	0.48
MCHC	33.8±	0.97	33.7±	0.38	34.2±	0.63	34.3±	1.19
PLT	1100.2±	118.27	1000±	89.05	1078.0±	132.60	1095.2±	65.97
No. of female	5		5		5		5	
WBC	7.2±	1.54	7.4±	1.60	8.4±	2.38	7.3±	3.03
RBC	8.0±	0.33	8.3±	0.25	8.2±	0.38	7.9±	0.48
HGB	14.9±	0.43	15.2±	0.58	15.0±	0.75	14.7±	1.03
HCT	45.0±	1.60	46.0±	1.73	44.5±	2.20	44.1±	3.31
MCV	56.2±	1.81	55.5±	1.72	54.4±	0.98	55.7±	2.44
MCH	18.6±	0.43	18.4±	0.65	18.3±	0.23	18.5±	0.63
MCHC	33.1±	0.53	33.1±	0.52	33.6±	0.36	33.3±	0.51
PLT	1057.4±	109.57	1024.6±	35.43	1048.0±	57.66	988.2±	92.43

All values are expressed as mean ± SD.

Significant differences as compared with control: * p < 0.05

WBC, white blood cell (10³/mm³); RBC, red blood cell (10⁶/mm³); HGB, hemoglobin (g/dl); HCT, hematocrit (%); MCV, mean corpuscular volume (μ³); MCH, mean corpuscular hemoglobin (pg); MCHC, mean corpuscular hemoglobin concentration (%); PLT, platelet (10³/μ³)

Table 8. Biochemical results in SD rats inhaled C.I.No. Reactive Red 195 for 4 weeks

	Control		10mg/m ³		40mg/m ³		160mg/m ³	
No. of male	5		5		5		5	
TP	6.0±	0.22	6.1±	0.16	6.3±	0.12	6.1±	0.33
BUN	13.0±	1.39	13.9±	1.78	15.5±	1.13	13.7±	1.99
CRTN	0.6±	0.04	0.6±	0.04	0.6±	0.08	0.6±	0.04
T-BIL	0.2±	0.05	0.2±	0.05	0.2±	0.04	0.2±	0.0
GLU	159.0±	14.58	149.2±	9.20	142.8±	17.96	142.2±	17.68
T-CHO	55.4±	13.11	50.4±	9.29	49.0±	6.0	47.8±	6.65
AST	91.6±	18.43	101.8±	13.48	107.4±	19.63	98.2±	8.20
ALT	32.6±	9.63	35.6±	5.94	41.4±	5.68	33.4±	5.50
ALP	244.0±	34.62	273.8±	51.30	298.4±	22.71	287.0±	16.58
LDH	483.8±	423.0	543.0±	324.57	593.2±	429.26	366.4±	331.38
No. of female	5		5		5		5	
TP	6.9±	0.08	6.4±	0.18*	6.6±	0.15*	6.7±	0.18
BUN	14.3±	2.93	15.2±	1.81	14.3±	1.76	16.4±	2.39
CRTN	0.7±	0.0	0.7±	0.05	0.6±	0.05	0.6±	0.05
T-BIL	0.2±	0.04	0.2±	0.0	0.2±	0.04	0.2±	0.05
GLU	128.6±	13.32	132.0±	8.97	123.6±	9.99	120.6±	10.90
T-CHO	69.8±	11.39	72.0±	13.32	71.0±	12.10	65.6±	12.18
AST	88.8±	6.91	98.0±	18.69	82.6±	5.18	98.4±	23.78
ALT	34.2±	1.79	40.0±	8.46	31.6±	4.51	33.0±	6.36
ALP	140.0±	50.40	141.8±	28.98	147.0±	35.73	153.0±	26.82
LDH	247.4±	90.86	233.2±	121.66	207.4±	129.17	267.8±	273.67

All values are expressed as mean ± SD.

Significant differences as compared with control: * p < 0.05

TP, total protein (mg/dL); BUN, urea nitrogen in blood (mg/dL); CRTN, creatinine (mg/dL); T-BIL, total bilirubin (mg/dL); GLU, glucose (mg/dL); T-CHO, total cholesterol (mg/dL); AST, aspartate aminotransferase (IU/L); ALT, alanine aminotransferase (IU/L); ALP, alkaline phosphatase (IU/L); LDH, lactic dehydrogenase (IU/L)

(Baselt, 1997),
 (monoacetylbenzidine)
 (diacetylbenzidine)
 (, 1996);
 , 1998),
 가
 (Bulbulyan et ai., 1995)
 (ACGIH)
 (A1)
 (, 2000; ACGIH, 2000),
 가
 C.I.No.
 Reactive Red 195

가
 cytochrome P450
 (伊東信行, 1993; 前川昭彦 林裕造, 1991).
 turn table air jet
 (Model No. DF-3, SIBATACo. LTD., Japan)
 1 ~ 50 μm
 가
 0.01 μm (60%) ~ 10 μm (15%),
 0.01 μm (30%) ~ 10 μm
 (5%)
 (warheit, 1993).
 C.I.No.

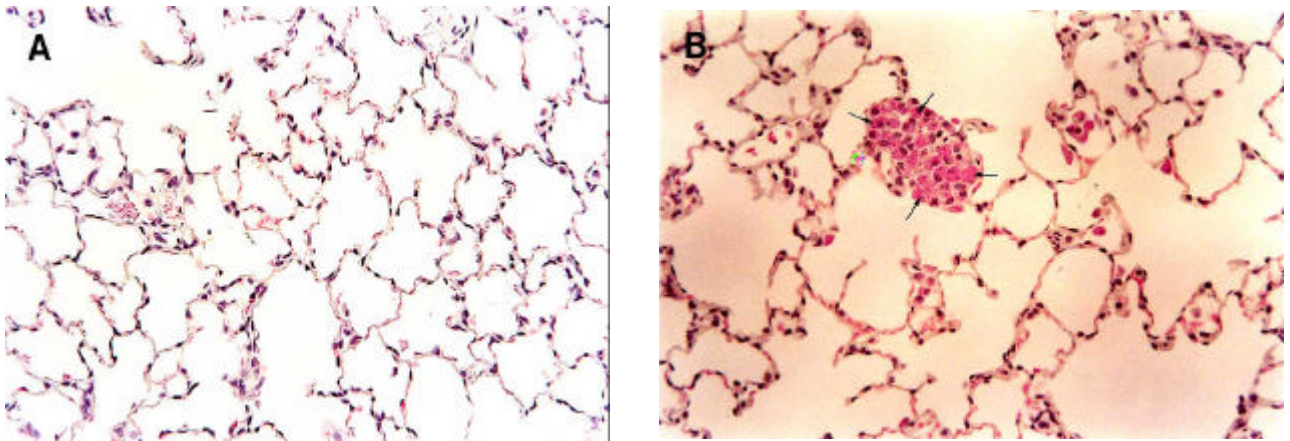


Figure 4. C.I.No. Reactive Red 195 dyes particles in the alveolar region. A, control(200x); B, exposed Reactive Red 195 dyes 160 mg/m³ (200x). Arrows indicate Reactive Red 195 dye particle ingested alveolar macrophages at the alveolar region.

Reactive Red 195 (table 4) 54.82 %가 160 mg/m³ (伊東信行, 1993), 가 (伊東信行, 1993) 11.16 % 가 (macrophage) 가 2.5 μ m 2.5 μ m (伊東信行, 1993) 가 3.3 μ m 0.21% Ballantyne (1994) Orasol Navy Blue clearance 가 2.3 mm/min (Wolff, R. K, 1992) 23mm (Schreider, 1983) 10 clearance가 Ballantyne가 S.D Red 195 1 6 , 5 , 4 (Wolff, R. K.,1992) 가 1.9-5.9 mm/min 32mm 가 가 5 μ m 0, 10, 40, 160mg/m³ (Phalen, 1984) 5 ~ 15 가 33.6 % 140 clearance 가 가 가 3.3 μ m 가 0.21% (no observed adverse effect level, NOAEL) 160 mg/m³ 15 clearance (stomach) 가

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 (Direct Black 38)
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