

1), 2), 3)  
1)†, 2), 2), 3)

- Abstract -

A Study of Environmental Hormone Characterisitics  
on Toxicity from Wooddust

Hee Lyun Park 1) · Nae Woo Lee 2) · Sung Bin Kim 2) · Dino L. Pisaniello 3)

Graduate school, Pukyong National University 1)

College of Engineering, Pukyong National University 2)

Dept. of Public Health, University of Adelaide, Australia 3)

This study was performed to evaluate tannin exposure by wooddusts for workers in furniture factories and to investigate the relationship between tannin exposure and sino-nasal cancer risk. In order to explore possible cytological changes leading to nasal cancer, we have examined 50 male furniture workers and 50 matched controls using brush cytology.

The results we have obtained in this study were as follows:

1. The tannin contents of woods used in woodworking factories have been measured and varied from 0.43 to 8.72 mg tannic acid equivalent per gram wood, for reconstituted softwood and turpentine (*Syncarpia glomulifera*) respectively.
2. Airborne tannins in wooddusts were also determined by area and personal exposure. The values of mean exposures for both methods are ranged from 3.1 to 5.0  $\mu\text{g}/\text{m}^3$  and from 4.6 to 14.5  $\mu\text{g}/\text{m}^3$  in furniture manufactures.
3. Over nasal cytology scores 2, the scores of study group were slightly more than control group and this kind of metaplasias seemed to be occurred

over 2  $\text{mg}/\text{m}^3$  wooddust and 6  $\mu\text{g}/\text{m}^3$  tannin exposure. Keratinising squamous metaplasia was investigated at nasal cytology score 3 and 10  $\mu\text{g}/\text{m}^3$  tannin exposure. The nasal cytology score 4 was seemed to be atypical squamous metaplasia.

4. To find out contributing factors to nasal cytology change, odds ratio that is one of fundmental biostatistics was applied. Actually the relationship between wooddust, tannin concentration and metaplasia were not meaningful, but the relationship between working experience more than 15 years and metaplasia was calculated as 1.83. This reveals that significant clinical abnormalities could be influenced from the years of woodworking experiences.

However further research is required to evaluate the significance of the data, for the purposes of sino-nasal risk assessment, standard setting to prevent nasal cancer occurrences and possibility of changing workplace.

Key Words : wood dusts, tannin concentration, personal exposure, nasal cytology score, nasal cancer

1999  
: 2000 6 2 , : 2000 10 10  
† : 100 ,  
Tel) 051-620-1518, E-mail) nwlee@pknu.ac.kr

(Hausen 1981 ; Linn et al, 1985 ; Gerhardsson et al, 1985).

(Bianco & Savolainen, 1994a).

가 (Pisaniello et al, 1995).

가 (Voss et al, 1985 ; Demers et al. 1997b).

(hard wood) (soft wood)

가

(Demers et al. 1997a).

가

Adenocarcinoma

가 1960

(Pisaniello et al, 1991).

가

100

(Pisaniello & Muriale, 1990b).

(Scheeper et al, 1995).

가

가

가 (personal exposure) (area exposure)

(Olsen et al. 1984 ; Dino (anterior rhinoscopy)

Pisaniello & Luciano Muriale, 1990a).

가 1 mg/m3

(A1) Nasal Cytology

5 mg/m3

(ACGIH, 1998), 가 8

Byssinosis Asthma Torjussen (Torussen et al, 1979)

(Paggiaro P. L. 1981), (sino nasal carcinoma) 가 가

NIOSH  
Adelaide  
(Pisaniello & Muriale, 1990)

2

(personal exposure) (area exposure)

1 (Inhalable Dust Monitor) SKC (IOM, Cat. No. 225-73), 25 mm Gelman A/E (glass fiber filter) 가 (SKC, Universal pump, model 224-PCXR8) 2 /min Mini-Buck M5

50 가

10 가 30 cm 가 (hemisphere)

Table 1 Hayfever Eczema , 가 가

가

10 44 20.3

Table 1. Basic characteristics of study and control group

	Woodworkers ( n=50 )	Controls ( n=50 )
Mean age (year)	38.1	38.7
Current smokers(%)	20	18
Hayfever experience(%)	42	50
Eczema experience(%)	8	6
Dry nose (%)	32	20
Block nose (%)	50	32

3

(Oi- Wah Lau et 96 %

al, 1989) , Pap-

50% anicolaou staining 가 ,

( ) 가

(FeCl3 가 80 20 가

( )

(Acetate buffer solution),

EDTA 1, 10- Phenanthroline 가

510  $\mu\text{m}$  1

가

Table 2

4 , PTFE,

Cellulose, Glass fiber PVC , 53

3

50 % 가

가

30 12

가 Notes

4 Turpentine

(Syncarpia glomulifera) ,

0.43- 8.72 mg as tannic acid/ g

50 Bianco

(anterior rhinoscopy) (Bianco & Savolainen, 1994b)

가

Torjussen 가

8 ,

Adelaide Table 3

Royal Adelaide

(brush cytological 가 가 ,

speciman) 가 가

Table 2. Tannin content of wood samples(mg tannic acid equivalent g-1 of wood)

Classification*	Name		Tannin conc. (mg /g dust)	Origin
	Common name	Botanical name		
Soft wood	Cedar, western red	<i>Thuja plicata</i>	1.76- 4.08	2)3)
	Fir, Douglas	<i>Pseudotsuga menziesii</i>	1.42	1)
	Pine, celery- top	<i>Phyllocaldus asplenifolius</i>	2.74	1)
	Pine, hoop	<i>Araucaria cunninghamii</i>	0.65	1)14)
	Pine, Huon	<i>Dacrydium franklinii</i>	0.85	1)
	Pine, kauri	<i>Agathis palmerstoni</i>	0.66	1)
	Pine, lodgepole	<i>Pinus contorta</i>	0.61	1) 2)
	Pine, radiate	<i>Pinus radiata</i>	1.24	1) 3) 4) 5)
Hard wood	Aningeria	<i>Sapotaceae</i>	1.08	5)
	Ash, alpine	<i>Eucalyptus delegatensis</i>	1.10	1)
	Ash, American	<i>Fraxinus americana</i>	0.63	2)3)
	Ash, mountain	<i>Eucalyptus regnans</i>	1.21- 1.54	1)
	Ash, European	<i>Fraxinus excelsior</i>	1.37	12)13)
	Ash, silver	<i>Flindersia bourjotiana</i>	0.48	1)
	Ash, white	<i>Eucalyptus fraxinoides</i>	0.67	1)
	Bean, black	<i>Castanospermum australe</i>	1.94- 1.99	1)
	Beech, European	<i>Fagus sylvatica</i>	0.27- 1.17	12)
	Beech, myrtle	<i>Nothofagus cunninghamii</i>	1.13	1)
	Blackbutt. W.A.	<i>Eucalyptus patens</i>	4.73	1)
	Black wood	<i>Acacia melanoxylon</i>	5.08- 7.43	1)
	Cherry	<i>Prunus avium</i>	1.54	3)12)13)
	Geronggang	<i>Cratoxylon arborescens</i>	0.86	7)8)9)10)
	Gum, blue, Sydney	<i>Eucalyptus saligna</i>	1.09	1)
	Gum, red, river	<i>Eucalyptus camaldulensis</i>	4.45- 4.75	1)
	Imbuia	<i>Phoebe porosa</i>	3.04	15)
	Iroko	<i>Chlorophora excelsa</i>	3.63	5)
	Jarrah	<i>Eucalyptus marginata</i>	2.01	1)
	Karri	<i>Eucalyptus diversicolor</i>	2.84	1)
	Mahogany, American	<i>Swietenia macrophylla</i>	2.42	3)
	Mahogany, Brazil	<i>Carapa guianensis</i>	2.78	15)
	Mahogany, Fijian	<i>Sweitenia macrophylla</i>	5.02	16)
	Maple, QLD	<i>Flindersia brayleyana</i>	0.98	1)
	Maple, sugar	<i>Acer saccharum</i>	0.61- 0.84	2) 3)
	Meranti, dark, red	<i>Shorea pauciflora</i>	0.95	7)8)9)10)
	Meranti, red	<i>Shorea</i>	1.29	7)8)9)10)13)
	Meranti, yellow	<i>Shorea faguettiana</i>	1.83	7)9)
	Nyatoh	<i>Sapotaceae</i>	1.85	7)8)9)10)11)
	Oak, American red	<i>Quercus</i>	2.77	2)3)
	Oak, American white	<i>Quercus</i>	2.01- 4.01	2)3)
	Obeche	<i>Triplochiton scleroxylon</i>	0.62	5)
	Purpleheart	<i>Peltogyne venosa</i>	1.96	3)5)
	Ramin	<i>Gonystylus macrophyllus</i>	0.52	8)13)
	Rosewood	<i>Pterocarpus indicus</i>	1.76	7)8)10)13)
	Sallywood, brown	<i>Acacia aulacocarpa</i>	1.95	1)
	Sheoak, W.A.	<i>Casuarina fraserana</i>	3.08	1)
	Tasmanian oak	<i>Eucalyptus delegatensis</i> , <i>Eucalyptus regnans</i>	2.55	1)
	Teak	<i>Tectona grandis</i>	0.91	1)
	Turpentine	<i>Syncarpia glomulifera</i>	8.72	1)
	Walnut, American	<i>Endiandra palmerstonii</i>	3.28	1)
	Walnut, European	<i>Juglans nigra</i>	1.38	12)13)
Reconstituted soft wood	Medium density F.B .		0.59	
	HMR Particle board		0.43	
	Chip board		0.43	

Notes for Table I:

1) Australia; 2) Canada; 3) USA; 4) New Zealand; 5) Africa; 6) Uganda; 7) Indonesia; 8) Malaysia;  
 9) Philippines; 10) Sabah; 11) Burma; 12) Europe; 13) Asia; 14) New Guinea 15) Brazil

\* Classification and name were cited from Australian Standard 2543 and 1148

Table 3. Tannin content by wood type

	Tannin concentration (mg /g dust)		
	Softwood	Hardwood	Recon.wood
Minimum	0.61	0.27	0.43
Maximum	4.08	8.72	0.59
Average	1.68	2.22	0.48
Median	1.33	1.83	0.43

2 TWA) Table 4

가

가

가

30 cm

5

가

(time weighted averaged contration : 가

Table 4. TWA & exposure range of woodworker's to airborne wood dusts and tannins

Activity	Sampling Method	Principal Wood	Inhal. dust (mg /m3)	Tannin conc. (µg / m3)	Remark
Sawing	Personal	Nyatoh, Jarrah, Tasmanian oak, Laminated	3.16 (0.87 10.33)	9.12 (4.20 20.52)	circular saws, band saws, profilers, dimension saws, straight line edgers, trimmers.
	Area	Chipboard, Veneer, Plywood	0.72 (0.19 1.08)	3.86 (0.92 7.33)	
Cutting	Personal	Aningeria, MDF Laminated	2.40 (0.70 6.65)	4.57 (3.68 7.46)	planers, thicknessers, moulders, shapers, mortisers, tenoners, spindle, moulders, copy lathes, router.
	Area	Chipboard Plywood, Nyatoh, Tasmanian oak	0.87 (0.15 1.76)	3.05 (1.06 4.69)	
Sanding	Personal	Laminated chip board, Veneer Blackwood, Aningeria,	5.31 (0.81 16.39)	14.53 (4.44 36.62)	Paper and block, Portable hand sand machines all kinds of sanding machines
	Area	Plywood, Ameri. Walnut,	2.23 (0.40 6.03)	5.02 (3.49 7.35)	

3. 가 가 Cytology  
 2.2 1.7  
 Nasal cytology 가  
 Fig. 1  
 50 가  
 Nasal cytology 가 2  
 Metaplasia 가 2 가  
 4 가  
 6 $\mu$ g/m<sup>3</sup>  
 Nasal cytology 가 3 Keratinising  
 squamous metaplasia 가 10  $\mu$ g/m<sup>3</sup>  
 가  
 4 Atypical squamous metaplasia  
 Squamous metaplasia Odds ratio ( Grantham, 1992 ; Beaglehole,

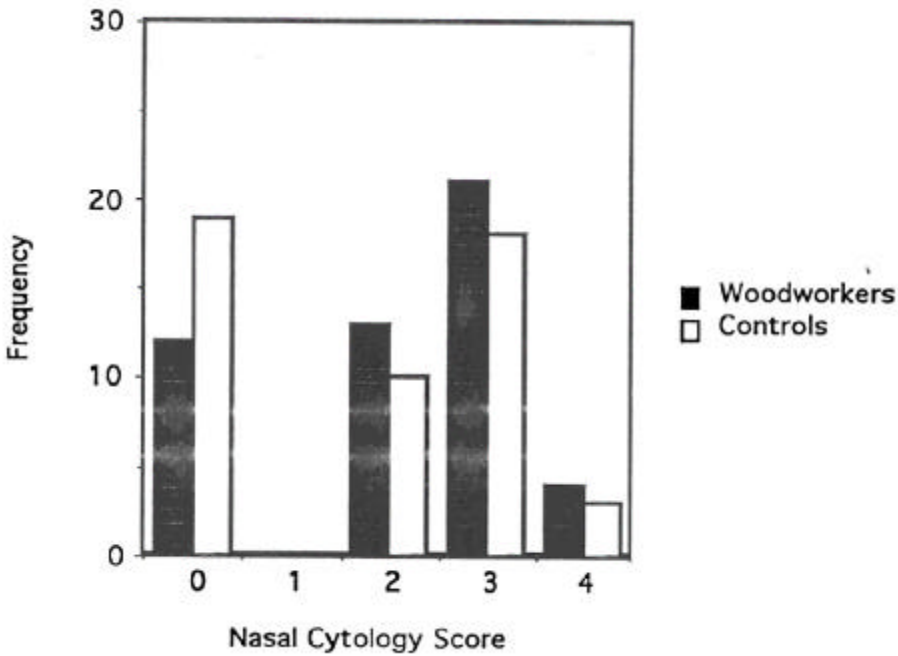


Fig. 1. Frequency distribution of nasal cytology scores.

1993 ; Philip Ryan, 1997 ) .

Odds ratio

15

metaplasia

가 1.83

metaplasia가

가

가

가

15

가 15

metaplasia가

가 1.83

Table 5

15

15

1.

가 가

Odds ratio

(0.43 mg /g ) turp-

entine[(*Syncarpia glomulifera*) : 8.72 mg

/g ]

Odds ratio = (16/7) ÷ (15/12) =  $\frac{16 \times 12}{15 \times 7} = 1.83$

2.

3.1 5.0  $\mu\text{g}$

/m<sup>3</sup> , 4.6 14.5  $\mu\text{g}/\text{m}^3$

3.

nasal cytology 2

가

cytology 2

2mg

/m<sup>3</sup> , 6 $\mu\text{g}/\text{m}^3$  Cytol-

ogy 3 10  $\mu\text{g}/\text{m}^3$  ,

keratinising squamous metaplasia

4

atypical squamous

metaplasia

가

가

가

4.

Table 5. Association between metaplasia and years of woodworking

		Years of woodworking		
		15	< 15	total
Metaplasia	yes	16	7	23
	no	15	12	27
	total	31	19	50



생의 상관성을 Odds ratio로서 계산한 결과는 대단히 미흡하였고, 15 년이상 근무한 경력자들과 metaplasia발생여부를 Odds ratio로 조사한 결과는 1.83 이었다. 이것은 코내부의 비정상상태를 발생시키는 가장 큰 인자가 장시간 근무한 년한이라는 것이다.

이상과 같이 작업장의 목재분진의 노출정도를 평가하고 코내부의 세포변화에 영향을 미치는 인자들을 조사하였으나 아주 미흡하므로 지속적인 보완연구가 필요한 것으로 사료된다. 그리고 목재분진이 발생하는 사업장에 종사하는 근로자에게 허용되는 적절한 근무기간은 어느 정도가 될 것이며, 이러한 직업병의 발생을 방지하기 위한 대책을 개발하는 것도 매우 시급하다.

## REFERENCES

- Pisaniello DL, Gun RT, Tkaczuk MN, Schulz MR, Stevens MW, Nasal Cytology in Australian Furniture Woodworkers, *Aus. J Otolaryngol* 1995; 2(2); 137-141
- Demers PA, Teschke K, Kennedy SM. What to Do About Softwood? A Review of Respiratory Effects and Recommendations Regarding Exposure Limits. *Am J of Ind Medicine* 1997; 31; 385-398
- Pisaniello DL, Connell KE, Muriale L Wood Dust Exposure During Furniture Manufacture - Results From An Australian Survey And Considerations For Threshold Limit Value Development, *Am Ind Hyg Assoc J* 1991; 52(11); 485-492
- Scheeper B, Kromhout H, Boleij JSM, Wooddust Exposure During Woodworking Processes *Ann Occup Hyg* 1995; 39(2); 141-154
- Olsen JH, Jensen SP, Hink M, Faurbo K, Oluf N, Jensen OM. *Ind J Cancer*. 1984; 34: 639-644
- Pisaniello DL, Muriale L. A Study of Occupational Exposure to Wood Dust and Noise in South Australian Furniture Factories, Final Report for the South Australian Guide of Furniture Manufactures, Dept. of Community Medicine, University of Adelaide; 1990.
- ACGIH. Threshold Limit Values for Chemical Substances and Physical Agents; 1998
- Paggiaro PL, Cantalupi R, Filieri M, Loi AM, Parlanti A, Toma G, Baschieri L. Bronchial asthma due to inhaled wooddust : Tanganyika aningre. *Clinical Allergy* 1981; 111; 605-610
- Bianco MA, Savolainen H. Woodworkers exposure to tannins. *J Applied Toxicology* 1994; 14(4); 293-295
- Hausen BM. Woods Injurious to human health, A manual, Water de Gruyter & Co. Berlin; 1981. p.127~137
- Holness DL, Andra M. Charles SK, Pilger W, Nethercott JR. Respiratory Function and Exposure Effect Relationships in Wooddust Exposed and Control Workers. *J of Occup Medicine* 1985; 27; 501-506
- Gerhardsson MR, Norell SE, Kiviranta HJ, Ahlbom A. Respiratory cancers in furniture workers *British J of Ind Medi* 1985; 42; 403-405
- Voss R, Stenersen T, Oppedal BR, Boysen M. Sinonasal Cancer and Softwood. *Acta Otolaryngol(Stockh)* 1985; 99; 172-178
- Torujussen W, Solberg LA, Hogetveit AC, Histopathological Chanfes of Nasal Muscoa in Nickel Workers. A Pilot Study 1979; 44: 963-974
- Lau OW, Luk SF, Huang HL. Spectrometric

Determination of Tannins in Tea and Beer Samples with Iron(III) and 1,10-Phenanthroline as Reagents, Analyst 1989; 114; 631-633

Grantham D. Occupational Health and Hygiene, Guidebook for the WHSO, OCCU-LINK books; 1992. P.34

Beaglehole R, Bonita R, Kjellstrom T. Basic Epidemiology, World Health Organization, Geneva; 1993. P.38

Ryan P. A Short Course in Elementary Biostatistics, A coursework book for students of medicine, Public health and the health sciences, University of Adelaide; 1997. P.36