Research on Toxicological Characteristics of Antibacterial Composite Materials

Gong Tai-sheng*, Hou Ya-ni, Pan Mei-li

School of Resource and Environment, Shaanxi University of Science and Technology, Xi'an, Shaanxi 710021, P.R. China

Abstract: Experiments were carried out for determining the acute dermal toxicity, dermal irritation and skin abnormality of antibacterial composite materials, according to the testing methods of technical specifications of toxic chemicals (2005'Version). The medium lethal dose in the group of acute dermal toxicity was greater than 2000 mg/kg, and the mean value of rabbit's dermal irritation was 1.67. The skin of guinea pigs appeared erythema in the group of skin sensitization, and the integral in each time of skin sensitization reached two. The results indicated that the acute dermal toxicity of antibacterial composite materials towards big mice belonged to low toxicity or actual non-toxic. The single intensity of irritation towards rabbit as well as the sensitized strength was slight.

Key words: antibacterial composite materials; toxicological characteristics; footwear

1 Introduction

Many kinds of antimicrobial agents and technique are used on footwear. The toxicological characteristics of antibacterial agent, however, affect the safety of products. In addition, the market of antibacterial materials in China is still in transition period from chaos to norms, unified evaluation standards for testing of antibacterial toxicology are still needed. In this research a new detecting method of antibacterial toxicological performance was designed and the toxicological characteristics of antibacterial agent made by ourselves were tested.

2 Experimental

2.1 Experimental Animals

1) Healthy adult male and female rats, 200 g~300 g in weight, ten in each group.

2) Four healthy adult male rabbits, with intact skin.

3) Fifteen nulliparous and non-pregnant healthy adult female guinea pigs.

2.2 Experimental Antibacterial Agents

In this research, the applied antibacterial agents include organic, inorganic and composite antibacterial agent which is compounded by above two.

2.3 Acute Dermal Toxicity Test of Antibacterial Agents

* Corresponding author, Email: skdgts@126.com, Fax: 029-86168316, Tel : 029-33571512

Testing rats have been shaved the hair and divided into four groups. The composite antibacterial agents are applied with 1000mg / kg, 1500mg / kg, 2000mg / kg and 2500mg / kg respectively. Then observe the toxic reaction and mortality of rates.

2.4 Dermal Irritation Test of Antibacterial Agents

The skin of testing rabbit is coated with composite antibacterial agent, about 0.5ml each time. Observe the testing parts and to assess the irritation degree after 1 hour, 24 hours and 48 hours respectively.

2.5 Skin Abnormality Test of Antibacterial Agents

After 10 to 14 days of induction phase, i.e. coating or injecting intradermally several times on the testing guinea pigs, the organic antibacterial agents with irritating does are coated and then observe the intensity of skin reaction, compare with non-coated ones[1].

3 Results and discussion

3.1 Acute Dermal Toxicity of Antibacterial Agents

Fig.1 Survived numbers after coating the antibacterial composite agents

By observing the rats' death situation (as shown in Fig. 3-1), it is clear that during the observation period, the survival rate of rats is a hundred percent, no death.

According to the data between the dermal toxicity grade (Tab. 1) and the experimental results (Tab. 2), we found that the acute dermal toxicity LD_{50} is greater than 2000mg/kg, which means the toxicity of antibacterial agents is low or actually nontoxic.

Tab.1 Dermal toxicity grading

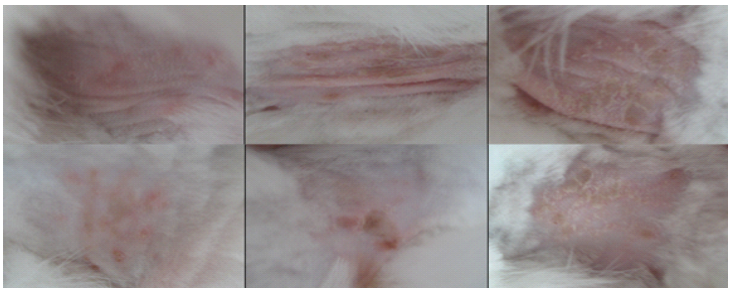
LD_{50}(mg / kg)	Toxicity grade
≤200	High
＞200～2000	Middle
＞2000～5000	Low
＞5000	Non-toxic

Tab.2 Test results of acute dermal toxicity

Sex	Does Group（mg/kg）	ID	Weight（x±SD）(g)			The number of animal died in 1-14 days													
			After zero day	After sever days	After fourteen days	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		1	185.84	186.23	187.63														
		2	172.82	172.81	185.84														
Female	1000	3	187.98	186.59	172.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	172.39	170.35	172.82														
		5	188.64	187.34	185.84														
		1	200.27	201.33	200.56														
		2	198.34	198.98	199.21														
	1500	3	191.12	190.25	192.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	188.87	187.56	189.35														
		5	201.93	201.37	200.45														
		1	218.26	219.27	217.56														
		2	218.07	217.56	216.53														
	2000	3	213.38	213.56	212.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Male		4	217.72	219.54	218.87														
		5	215.09	216.57	214.56														
		1	205.35	204.23	208.54														
		2	214.86	213.24	212.56														
	2500	3	238.92	238.12	239.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	209.36	210.37	211.54														
		5	222.28	223.41	220.45														
Mortality are zero																			

3.2 Dermal Irritation of Antibacterial Agents

By observing the skin changes of rabbits' (as shown in Fig. 2), we saw erythema and eschar after coating antibacterial composite agents.



After 1 hr　　After 24 hrs　　After 48 hrs

Fig.2 Skin changes on testing parts of rabbits

According to the data of dermal toxicity grade (Tab. 3) and the experimental results (Tab. 4), we can get the conclusion: in the dermal irritation test, the mean value of rabbit's dermal irritation is 1.67, which means the irritation of antibacterial agents is light.

Tab.3 Grading standard on the intensity of dermal irritation

Mean Value	Intensity of Irritation
0～0.5	Non- irritation
0.5～2.0	Light
2.0～6.0	Middle
6.0～8.0	High

Tab.4 Test results of acute dermal irritation

			After 1 hr						After 24 hrs						After 48 hrs					
			Sample			Reference			Sample			Reference			Sample			Reference		
ID	Sex	Weight (g)	Erythema	Edema	Score	Erythema	Edema	Score	Erythema	Edema	Score	Erythema	Edema	Score	Erythema	Edema	Score	Erythema	Edema	Score
1	Male	2118	1	0	1	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
2	Male	1962	1	0	1	0	0	0	2	0	2	0	0	0	2	0	2	0	0	0
3	Male	1871	1	0	1	0	0	0	2	0	2	0	0	0	2	0	2	0	0	0
4	Male	2084	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total score			1.67																	
Intensity of skin reaction			Light																	

3.3 Skin Abnormality of Antibacterial Agents

In the tentative tests the induced concentration and inspired concentration of organic antibacterial agent were set to 1‰ and 0.5‰ respectively. By observing the skin changes (as shown in Fig. 3), we saw light erythema on the skin.

Fig.3 Skin changes on testing parts of guinea pigs

According to the data of intensity of irritation (Tab. 5) and the experimental results (Tab. 6), we can get the conclusion: in the test of skin abnormality, there is no guinea pig which the total score of skin abnormality is above two. The test results of skin abnormality are negative, anaphylactic rate is 25%, which means the skin abnormality is slight.

Tab.5 Grading standard on intensity of irritation

Sensitization rate (%)	Intensity of irritation

0～8	Weak
9～28	Light
29～64	Middle
65～80	High
81～100	very high

Tab.6 Testing results on dermal irritation of guinea pigs with organic antibacterial agents

Group	Numbers	Induced does	Inspired does	Observing time (hrs)	Dermal reflection									Numbers(≥2) %
					Erythema					Edema				
					0	1	2	3	4	0	1	2	3	
Negative control group	4	—	0.5‰	24	4/4					4/4				0
				48	4/4					4/4				0
The testing group	4	1‰	0.5‰	24		1/4				4/4				25
				48		1/4				4/4				25
Positive control group	4	2.5%	1.0%	24		2/4	2/4				4/4			100
				48		2/4	2/4				4/4			100

4 Conclusions

1) The acute dermal toxicity LD_{50}> 2000mg/kg, which means the toxicity of antibacterial agents, is low or actually nontoxic.

2) The mean value of rabbit's dermal irritation is 1.67, means the irritation of composite antibacterial agents is light.

3) In the test of skin abnormality, there is no guinea pig which the total score of skin abnormality is above two. The test results of skin abnormality are negative, anaphylactic rate is 25%, which means the skin abnormality of organic antibacterial agent is slight.

Reference

[1] Wang Jun-qi; Wang You-bin; Pan Li-jun. The security requirements on the traditional standards for the anti-bacteria knitted fabric [J]. Knitting industries, 2006, (08)