

The Relationship of Tofu Coagulants and Irritant Contact Dermatitis in Tofu Maker at Serang Banten Indonesia

ABSTRACT

Irritant contact dermatitis (ICD) is the second most prevalent occupational ailment, following musculoskeletal disease. This condition occurs due to direct exposure to irritants, either acutely or persistently. The primary irritants responsible for contact dermatitis are acids or bases. The individuals most susceptible to contact dermatitis are the staff working in the tofu sector. This is because coagulants come into direct touch with personnel during the tofu production process. The study design is an observational analytic approach utilizing the cross-sectional method, which involves a questionnaire. According to this research, the prevalence of ICD among tofu makers in Serang is 59.8%. 85.9% of the workers in this industry are male. The study found that 79.3% of workers had an ICD, 16.3% had a history of atopic conditions, 6.5% always used Personal Protective Equipment (PPE), 93.5% had adequate personal hygiene, and 55.4% had a strong awareness of the ICD. The chi-square data analysis revealed that exposure to tofu coagulants is a causative factor instead of the protective factor for ICD, with a p-value of less than 0.001 and an odds ratio of 0.164. There is a correlation between the coagulants used in tofu production and the incidence of ICD in tofu manufacturers in Serang city.

Keywords: Irritant Contact Dermatitis, Tofu Coagulants, Irritant, Tofu Maker

INTRODUCTION

Contact dermatitis is characterized by skin inflammation resulting from contact between skin tissues and compounds that cause an allergic reaction (Allergic Contact Dermatitis, ACD) or substances that irritate (Irritant Contact Dermatitis, ICD). Acutely or chronically irritating the skin will result in skin damage, activating an innate immune response. The compounds causing ICD include acids, bases, salts, detergents, soaps, and topical medicinal treatments. The extensive utilization of irritating compounds in the industrial sector heightens the susceptibility of workers in the field to develop skin illnesses. Occupational skin diseases (OSDs) are the second most prevalent, following musculoskeletal diseases [1-3].

Based on statistics provided by the National Institutes of Occupational Safety and Health, the incidence rate of dermatitis was 10.2%. Throughout 2007, the recorded incidence of infectious and communicable diseases (ICD) throughout Indonesia was 6.78%, with the specific incidence of ICD in the Banten region totalling 5.33% [4-5].

An example of an industrial worker vulnerable to ICD is a factory worker with expertise in the manufacturing sector. Rhizkiyana SD conducted a study that revealed that 60.8% of employees have an ICD [6]. The elevated prevalence of ICD among manufacturing workers is attributed to their exposure to irritants, including salts or acids [7,8]

This study aimed to ascertain the frequency of ICD (Irritant Contact Dermatitis) among industrial workers who know of such incidents, the specific attributes of these incidents, and the potential link between exposure to clamping chemicals and the occurrence of ICD in these individuals.

MATERIALS AND METHODS

This study involved 92 participants who worked in tofu factory-micro small and medium enterprises in Serang city. This research was conducted from January 5, 2023 until March 30, 2023. Our study utilizes observational analytics and adopts a latitude-cutting strategy. Our research aimed to ascertain the frequency of ICD among manufacturing workers and investigate the correlation between exposure to cluster chemicals and cases of ICD. The study included primary data collected via questionnaires validated by manufacturing personnel who knew about the attack.

This study has a minimum sample size of 92 individuals. We determine the quantity of those samples by employing the formula for proportional testing. Consecutive sampling is a method of selecting respondents based on specific criteria for inclusion and exclusion of subjects. The equipment and resources utilized in this study include informed permission forms obtained from the participants, questionnaires printed on paper, and writing instruments such as pencils. The research was conducted through team member interviews utilizing a questionnaire, and the data was analyzed using the Statistical Package for the Social Science application (SPSS) version 27.

RESULTS

The study excluded 10 respondents because their questionnaire replies were incomplete, 7 respondents because one of them refused to participate, and 6 respondents because they were unable to speak the Indonesian language. The survey revealed that 85.9% of the workforce consisted of males. Additionally, 20.7% of the workers had been employed for less than 6 weeks, while 44.6% exhibited inadequate knowledge. Furthermore, 15% had a previous record of atopy, and 54.3% had a history of ICD. Only 6.5% demonstrated satisfactory adherence to personal protective equipment (PPE), but 93.5% maintained good self-hygiene practices. Table 1 presents the data that represents these specific characteristics.

Table 1 Respondent's characteristic

Characteristic	n	%
Gender		
Men	79	85,9
Women	13	14.1
Coagulant exposure		
Working time < 6 weeks	19	20.7
Working time \geq 6 weeks	73	79.3
Irritant Contact Dermatitis		

Negative	37	40.2
Positive	55	59.8
Knowledge History		
Bad	41	44.6
Good	51	55.4
Atopic History		
Negative	77	83.7
Positive	15	16.3
Irritant Contact Dermatitis History		
Never	42	45.7
Ever	50	54.3
Personal Protective Equipment Usage		
Disobedience	86	93.5
Obedience	6	6.5
Personal Hygiene		
Bad	6	6.5
Good	86	93.5

In this investigation, we conducted a Chi-square or Fisher's exact test using SPSS with a 95% confidence interval (CI). The study data, analyzed using Chi-Square testing, showed a significant link between clamp exposure and the occurrence of ICD in workers. The p-value was less than 0.05, and the OR was 0.164 (Table 2).

Table 2. Relevance between coagulating agents exposure and ICD

	ICD		Total	P-value	OR (CI 95%)
	Yes	No			
Coagulant exposure				<0.001*	0.164 (0.05-0.5)
exposure \geq 6 weeks	50 (68.5%)	23 (31.5%)	73 (100%)		
exposure < 6 weeks	5 (26.3%)	14 (73.7%)	19 (100%)		

Total	55 (59.8%)	37 (40.2%)	92 (100%)
--------------	------------	------------	-----------

^{*)} Chi-square

The study additionally examined data about the correlation between adherence to PPE usage and events involving ICDs. The findings of Fisher's test indicated a significant association between adherence to PPE usage guidelines, with a p-value less than 0.001 and an odds ratio of 0.36 (Table 3).

Table 3. Relevance between personal protective equipment usage obedience and ICD

	ICD		Total	P-value	OR (CI 95%)
	Yes	No			
PPE usage				0.003 ^{**}	0.36 (0.3-0.5)
Disobedience	55 (51.4%)	31 (34.6%)	86 (100%)		
Obedience	0 (0.0%)	6 (100%)	6 (100%)		
Total	55 (59.8%)	37 (40.2%)	92 (100%)		

^{**}) Fisher's Exact Test

The chi-square test analysis revealed no significant link between the atopic history and the occurrence of ICD, as indicated by a p-value of 0.89, which is greater than 0.05. Table 4 displays the findings of the investigation.

Table 4. Relevance between atopic and ICD

	ICD		Total	P-value
	Yes	No		
Atopic history				0.89 [*]
Negative	47 (59.5%)	32 (40.5%)	79 (100%)	
Positive	8 (61.5%)	5 (38.5%)	13 (100%)	
Total	55 (59.8%)	37 (40.2%)	92 (100%)	

^{*}) Chi-square

The Fisher test, a statistical analysis examining the association between self-hygiene and the incidence of ICD, did not reveal a significant correlation, as shown by a p-value greater than 0.05 (0.4). The findings of the investigation are displayed in Table 5.

Table 5. Relevance between personal hygiene and ICD

	ICD		Total	P-value
	Yes	No		
Personal Hygiene				0.4**
Bad	5 (83.3%)	1 (16.7%)	6 (100%)	
Good	50 (58.1%)	36 (41.9%)	86 (100%)	
Total	55 (59.8%)	37 (40.2%)	92 (100%)	

**) Fisher's Exact Test

The Fisher's test, a statistical test examining the association between knowledge level and ICD occurrence, did not reveal a significant link, as shown by a p-value greater than 0.05 (0.2). Table 6 displays the findings of the analysis.

Table 6. Relevance between knowledge level and ICD

	ICD		Total	P-value
	Yes	No		
Knowledge level				0.2**
bad	28 (68.3%)	13 (31.7%)	41 (100%)	
good	27 (52.9%)	24 (20.5%)	51 (100%)	
Total	55 (59.8%)	37 (40.2%)	92 (100%)	

**) Fisher's Exact Test

DISCUSSION

The survey found that 59.8% of factory workers in Serang had Chemical Dermatitis (CD). Most of these workers were male, comprising 85.9% of the total. The data revealed that the incidence of ICD among Serang workers in 2007 was more significant than the incidence of ACD in the Banten population (5.33%) or Indonesia (6.78%). The study reported a considerable occurrence rate due to its focus on workers directly exposed to irritants in their occupational settings [4].

The study found that 79.3% of employees had a job duration exceeding six weeks. Rhizkiyana's study, conducted in 2019, reported a prevalence rate of 60.8% for ICD among employees, aligning with the current findings [6]. Typically, work-related ICD (illness or injury) will manifest within the initial 6 weeks of employment [7]. The recruitment of new workers during the acute phase leads to the absence of tolerance for irritants produced by the mechanisms of the innate immune system [9].

Based on the questionnaire, 54.3% of employees reported a history of ICD, whereas 16.3% reported a history of atopic conditions. We examine the historical background of ICD and atopic conditions as potential risk factors for ICD. This is because they have the potential to cause skin damage, which in turn increases the probability of developing an ICD upon future exposure. The citation for the source is Patel and Nixon (2022). According to a study conducted by Ahmadi, the findings revealed a percentage of 77.6% [10]. The respondents in that survey had a more advanced comprehension of ICD than those in our study. The disparity may be attributed to the fact that the participants in the prior investigation were healthcare professionals who generally possessed greater educational attainment than those employed in the factory setting [10].

The compliance rate for PPE among production workers in Serang is 93.5 percent, indicating a low level of adherence. This finding aligns with prior studies, which reported a prevalence rate of 66.2 percent. During team member interviews, it was reported that using PPE, such as gloves, hampers their work productivity, even in cases where they do not utilize it [6]. Based on the study, most workers, precisely 93.5%, demonstrated commendable self-hygiene practices. This aligns with Salamah's study [11]. The study revealed 88.9% of employees demonstrated commendable personal cleanliness [12].

A significant association was observed between the exposure of clamping compounds to ICD (p-value < 0.001; OR = 0.14) and the utilization of PPE in response to ICD (p-value < 0.001, OR = 0.36) in the relationship analysis. The data analysis indicated that long-term exposure to clamping chemicals and regular use of personal protective equipment (PPE) protects against the development of ICD. Constant exposure to the skin can lead to increased individual irritant tolerance by stimulating the growth of keratinocytes and the synthesis of lipids, which in turn heal the epidermis. The citation for this source is Patel and Nixon (2022). The mechanism will subsequently amplify trans-epidermal water loss (TEWL), augmenting irritant tolerance. Developing a tolerance to clotting agents will result in less severe clinical symptoms compared to the initial acute phase [9].

Adhering to PPE guidelines can help prevent the development of ICD. This finding aligns with a study conducted by Rais et al., which showed a notable correlation between the utilization of a specific technology and the incidence of ICD [12]. Personal protective equipment (PPE), such as gloves, can operate as a protective factor by preventing direct

contact between the irritant and the skin, hence mitigating the occurrence of irritation on the skin [2].

The research found no statistically significant association ($p\text{-value} > 0.05$) between the occurrence of ICD and the presence of an atopic history. The findings of our study are consistent with the research conducted by Salamah, as indicated by a $p\text{-value}$ of 0.08 [11]. An individual with a history of atopic allergies is prone to hypersensitivity or allergic reactions, including bronchial asthma, allergic rhinitis, atopic dermatitis, and food allergies. Patel et al. and Vaillant et al. have defined a history of atopic allergies as a condition marked by heightened sensitivity or allergic reactions, including bronchial asthma, allergic rhinitis, atopic dermatitis, and food allergies. The study produces inconclusive findings due to its focus on the broader history of atopic rather than specifically on atopic dermatitis [2, 13].

The analysis of the correlation between self-hygiene and the occurrence of ICD did not reveal any statistically significant link, as shown by a $p\text{-value}$ greater than 0.05. Gita's investigation, which yielded a $p\text{-value}$ of 0.26, is consistent with this one [14]. Maintaining good hygiene can be a preventive measure against various ailments. This study assessed self-hygiene levels through the administration of a questionnaire. The study evaluated multiple facets of personal hygiene, encompassing hand hygiene, bathing practices, and using uncontaminated water. Workers frequently encounter irritants directly with their hands. These findings indicate that workers should prioritize hand hygiene practices in their self-hygiene assessments. This includes washing their hands with soap and running water before and after coming into contact with irritants, following a six-step routine, and ensuring their hands are well-dried [14].

The study discovered no statistically significant correlation between the level of knowledge and the incidence of ICD, as indicated by a $p\text{-value}$ greater than 0.005 (0.14) [15]. Previous research suggests that the level of education does not impact the occurrence of ICD. However, there is a correlation between the team member's attitudes and the incident. The information linked to the ICD acts as a deterrent. This information can serve as a basis for molding our attitudes. However, it is essential to note that possessing extensive information does not necessarily guarantee the presence of suitable attitudes. Therefore, knowledge alone does not directly correlate with the occurrence of an ICD event. The findings of this investigation possess certain unexplored functions. Age, humidity, and extreme temperatures all contribute to the situation. This study in 2013 examines the acute and chronic phases of ICD in hairdressers exposed to irritants such as nickel, formaldehyde, and ammonium thioglycolate. Moreover, this study has constraints in accurately diagnosing ICD in workers. The study employs expert panel-administered questionnaires to identify ICD [16].

CONCLUSION

The incidence rate of Irritant Contact Dermatitis (ICD) among Serang, Banten province production workers was 59.8%. 85.9% of these workers were male, constituting the majority. The labourers possessed the following attributes: 79.3% of the participants had been employed in the production department for more than 6 weeks. 54.3% had a previous history of ICD. 16.3% had a history of atopic dermatitis. 55.4% had a good level of awareness of ICD. 6.5% followed the use of advanced PPE correctly. About 93.5% maintained appropriate

cleanliness. Exposure to coagulants for more than 6 weeks provides a preventive effect against the incidence of ICD.

ETHICAL APPROVAL

This study was approved by the Health Research Ethics Commission (KEPK) FK UNTIRTA on February 17, 2023 with approval number 30/UN43.20/KEPK/2023.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist

References

1. Johansen, J. D., Bonefeld, C. M., Schwensen, J. F. B., Thyssen, J. P., & Uter, W. Novel insights into contact dermatitis. *Journal of Allergy and Clinical Immunology*. 2022;149(4): 1162–1171. <https://doi.org/10.1016/j.jaci.2022.02.002>
2. Patel, K., & Nixon, R. Irritant Contact Dermatitis — a Review. *Current Dermatology Reports*. 2022;11(2): 41–51. <https://doi.org/10.1007/s13671-021-00351-4>
3. Sedó-Mejía, G., Soto-Rodríguez, A., Pino-García, C., Sanabria-Castro, A., & Monge-Ortega, O. P. Contact dermatitis: Clinical practice findings from a single tertiary referral hospital, a 4-Year retrospective study. *World Allergy Organization Journal*. 2020;13(7): 100440. <https://doi.org/10.1016/j.waojou.2020.100440>
4. Agency for Health Research and Development. *Basic Health Research: 2007 National Report*; 2008
5. Cohen, D. E. Irritant Contact Dermatitis. In J. L. Bolognia, J. V Schaffer, J. P. Callen, E. W. Cowen, G. J. Hruza, J. L. Jorizzo, H. Lui, L. Requena, T. Schwarz, & A. Torrelo (Eds.), *Dermatology* (4th ed., Vol. 2, pp. 262–273); Elsevier; 2018
6. Rhizkiyana, S. D. Determinants of the incidence of contact dermatitis in tofu industry workers in Tamanan District, Bondowoso Regency. 2019 https://repository.unej.ac.id/bitstream/handle/123456789/100616/SHELVY_DINDA_RHIZKIYANA-152110101074.pdf?sequence=1&isAllowed=y
7. Dewi, S. R., Handayani, R., Bakar, A., & Ramli, S. Utilization of Bittern and Vinegar as Coagulants in Making Tofu. *Eco-Innovation*. 2021;2(2):2–7. <http://repository.poltekkespim.ac.id/id/eprint/435/>
8. Napid, S., Oktaria, S., Setia Budi, R., Rizaldi, R., Palevi, R., Engineering, F., Medicine, F., & Agriculture, F. Socialization of the use of soybeans as a tofu product and its impact in Pelawi Utara Village, Babalan District, Langkat Regency. *JURPAMMAS*. 2022;2(1):67–72.
9. Eberting, C. L., Blickenstaff, N., & Goldenberg, A. Pathophysiologic Treatment Approach to Irritant Contact Dermatitis. *Current Treatment Options in Allergy*. 2014;1(4):317–28. <https://doi.org/10.1007/s40521-014-0030-0>

10. Ahmadi, A. A.. The relationship between the level of knowledge and the incidence of irritant contact dermatitis among health workers at the Bilokka Community Health Center, Sidenreng Rappang Regency. Muhammadiyah University. 2021
11. Salamah, A. N. Contact Dermatitis in PT Waskita Karya Construction Workers, World Class University Project at the University of Indonesia in 2012. 2012
12. Rais, R., Amir, R., & Muin, H. (2022). Factors influencing the incidence of dermatitis in tofu factory workers in Soreang District. *J-HESTECH*. 2022; 5(2): 83–96.
13. Vaillant, A. A. J., Modi, P., & Jan, A. Atopy. In *Immediate Hypersensitivity Reactions*. StatPearls Publishing. 2022
14. Megantari, G. Contact dermatitis in tofu factory workers. *HIGEIA Journal Of Public Health Research And Development*. 2020;4(Special 1): 112–123.
15. Warahma, M. (2020). The Relationship between Knowledge, Attitudes and Behavior of Laundry Workers towards Contact Dermatitis in Bebesen District, Central Aceh Regency, *Health Science journal*: p-ISSN: 2723-4339 e-ISSN: 2548-1398 Vol. 1, No. 6, December 2020;1(6):385–392.
16. Fabrigar, L. R., Smith, S. M., Petty, R. E., & Crites, S. L. Understanding Knowledge Effects on Attitude-Behavior Consistency: Role of Relevance, Complexity, and Amount of Knowledge. *Journal of Personality and Social Psychology*. 2006;90(4):556–577.