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Correlation between Farmer's Respiratory Health and Indoor Air Quality in Pulokerto and Sungai Rebo Wetland Area

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Abstract

Wetland areas have humid temperatures and residential development will have a major effect on the air quality in the room which becomes humid and humid room air can cause several symptoms of respiratory disorders caused by airborne. This research was conducted in 35 farmer's houses which aims to determine the relationship between the respiratory health of farmers with air quality in the farmhouse and obtained results that are not related to the respiratory health of farmers with air quality in the room, where P>0.05 and there is one house that has good quality. high physical conditions such as humid temperatures and high chemical quality of the air due to storing tools and plowing fields at home with a fairly high number of bacteria and fungi.

Keywords: COPD, Farmer's health, Marshes, South Sumatera

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1. Introduction

Wetlands are defined as swampy areas, low land surfaces that hold water and had characteristics such as mosses and grasses that grow in water either naturally or artificially; permanent or temporary where the water flow was stationary or flowing, slightly salty, including marine areas where at low tide the depth is not more than 6 meters [1]. Meanwhile, according to the American Geological Survey, wetlands are land surfaces where the area holds water seasonally or permanently such as lakes, rivers, estuaries, and freshwater swamps; lowlands covered in fresh or salt water in a certain period. Wetlands serve as a major factor in maintaining the environment associated with animals and plants.

Wetland areas have humid temperatures and if the area is built with residential houses, it will most likely affect the air quality in the room which becomes humid and if the air in the room is humid it can cause some symptoms of respiratory disorders caused by airborne. Research conducted by [2] found that there was a significant relationship between humid places and airborne diseases. Relatively humid places there tends to be the growth of microorganisms in the air which can pollute indoor air.

Microorganisms in indoor air can contain mycotoxins, aflatoxins, βglucans and allergens. [3] Found that the cause of allergies was not only found in microorganisms such as bacteria and fungi in the air but also in particulate matter (PM) consisting of PM1, PM2.5 and PM10. Air pollution can be affected by climate change, and environmental factors. The cause of respiratory allergies can be influenced by the home environment. According to the American Public Health Association, a home is said to be healthy if it fulfills basic physical needs such as a lower temperature than the air outside the house, adequate lighting, comfortable ventilation, and protects against transmission of infectious diseases, namely having clean water supply, waste disposal facilities and sewerage. Waste water that has good sanitation and meets health requirements. Researchers took samples of farmer's houses because farmers generally brought home their harvest and farming tools and placed them in the house which could interfere with the air quality in the room. Meanwhile, the average farmer's house has a house with less ventilation and lighting. Research according to [4] The more weathered, damp, and moldy areas significantly increase the risk to the health of the occupants of the house. In addition, if you don't have adequate ventilation in the house, it can create damp walls. According to [5] particulate matter (PM), formaldehyde, Volatile Organic Compounds (VOC), Semi Volatile Organic Compounds (SVOC), carbon dioxide, carbon monoxide, exhaust gases from combustion / heating, particles of bacteria and fungi in the air are components of pollution. the most common air in a house.

In Indonesia, according to [6], farmers depend on the presence of pesticides, where according to the Directorate General of Infrastructure and Facilities, the Directorate of Fertilizers and Pesticides, there is an increase in the amount of pesticides from year to year. The pesticide is inhaled through the sprayed plants. At the time of spraying, farmers do not use standard personal protective equipment and they can come into direct contact with high concentrations of pesticides. According to [7], Toxic pesticides have the potential to pose a danger to one's health with an incidence rate of about 1.17 per 100,000 in full-time workers. When a person is exposed to pesticides, the most common symptoms are coughing, sneezing, asthma attacks, and inflammation of the airways. The syndrome of pesticide poisoning in a person can be caused by pesticide neurotoxicity where the poison can interfere with nerve conduction by targeting the voltage / Na + / K + ATPase ion channel door, disrupting nerve transmission which is inhibited by acetylcholine esterase, stimulating respiratory sensory nerves / initiating pro-inflammatory signals which have an impact on lungs and airways, causing disruption of the respiratory system. Exposure to high doses of organochlorines, organophosphates, and pyrethroids can cause damage to the central nervous system and peripheral systems. The route of exposure through inhalation and absorption from the skin is the main route of exposure at work.

Exposure due to inhalation occurs when using volatile pesticide products especially when a person is not wearing a mask or with poor work ventilation. Exposure to inhalation of aerosols contaminated with pesticides can combine with particulate matter (PM). Pesticide levels in a person's body can be checked by bio monitoring where there can be a significant decrease in red blood cell cholinesterase levels associated with the duration of pesticide use. This is the main factor that triggers accidents and diseases in farmers which have an impact on the decline in farmer performance so that it can cause losses for farmers both socially and economically [13]. This is because the application of occupational safety and health (K3) by farmers is generally still low because they are considered taboo, useless, uncomfortable, impractical and even tend to interfere with the process of their farming activities. Lack of understanding of the risks faced have an impact on their health and safety such as injuries, accidents, disability to the impact on death.

Research in Tanzania, more than half of farmers store their pesticides indoors and in rooms where family members usually gather. Storage of pesticides like this can trigger poisoning accidentally and can even endanger the health of children. When pesticides are placed in the outside environment, the residue from pesticides that are in contact with rain/irrigated water can contaminate the environment such as soil, water, and home ecosystems contaminated with pesticides which can increase exposure to workers [8]

2. Materials and Methods

A cross sectional study was performed January 2022 until finish with an observational analytic on Sungai Rebo and Pulokerto’s wetland. Sungai Rebo is a wetland area which isn’t always covering by the highest tides of river. The area will be flooding at least 4 / 5 times in a 14 days. On a rainy day potentially for rice farming but while summer this area potentially for secondary crops. Pulokerto's area is a wetland area which always covering by the highest tides of river. This area located on hollow of the river / near the river and potentially for rice farming twice a year because they have supply on every season.

The Population target of this research are all of the farmers who living on Sungai Rebo and Pulokerto's wetland and the sample are all of the population target who has registered as a farmer on Sungai Rebo and Pulokerto's wetland at least ≥ 2 years, having a house built on wetland area/near the wetland are. Some diseases being a exclusion criteria such as Tuberculosis, COVID, Pneumonia, Chronic Obstructive Pulmonal Disease (COPD), chronic asthma while taking a sampling and respondents unwilling to answer. Total sampling of this research are 35 samples, Using the formula of Lameshow, 1997:

$$n = \frac{1.96^2 * p(q)}{d^2}$$

$$n = \frac{1.96^2 * 0{,}09(0{,}91)}{0{,}1^2} = 31{,}45$$

Minimum of every sample were fixed it 32 samples and plus of 10% opportunity of withdrawal so the total sampling are 35 samples. Dependent variable is respiratory health status, independent variable is physical indoor air quality (Temp, Relative Humidity, $PM_{2.5}$, PM_{10}), Chemical indoor air quality (CO_2, TVOC, HCHO), Biological indoor quality (bacterial and fungal).

At the time of sampling using their respective techniques, such as for taking PM2.5, PM10, temperature, and humidity by placing the Krissbow KW06561 brand at an altitude of ± 1 meter, and leaving it for 24 hours/house. For taking CO2, HCHO, and TVOC using the Air quality Detector Stellate AQ300 pro, sampling was carried out by taking the average value for 3 minutes in the afternoon after the farmer returned home. In taking air quality, Biology cooperates with a team from BBLK for breeding.

All the inspection tools are placed at the family gathering point. After all the sampling was collected, the data was processed using SPSS 25 using the Mann Whitney test if the data was not normally distributed and the T - Test if the data was normally distributed. For bivariate test using Pearson correlation test for normally distributed data and Spearman test for data not normally distributed. Multivariate test using logistic regression.

3. Results and Discussion

In the univariate results, from 35 samples, the average value was 49.42±13.11 and the median value was 50 (29-80) with 13 samples of male and 22 female. For the length of work with a sample of 35 people, the average was 0.80± 0.41 with a median value of 1 (0-1), duration of work has an average of 0.43±0.50 with a median value of 0 (0-1), and the last working frequency has an average of 0.63±0.49 with a median value of 1 (0- 1). From the physical quality variable, PM10 air has an average value of 19.14±12.81 and a median value of 17(10-88), then the physical quality of PM25 air has an average value of 19.05±25.84 and a median value of 31.1(5-162), then physical quality air temperature has an average value of 31.34±1.36 and a median value of 14 (29-34), then the physical quality of air relative humidity has an average value of 63.74±4.16 and a median value of 65 (56-76).

Chemical quality of CO2 air has an average value of 596.83±155.68 and a median value of 560 (329-1072), Formaldehyde air chemical quality has an average value of 0.46±2.47 and a median value of 0.014(0.-14.65), air chemical quality TVOC has an average value of 0.50±0.75 and a median value of 0.20(0-2.56), the biological quality of the total bacterial air has an average value of 0.28 ±58.35 and a median value of 301(86-301). -mean 283.40±58.35 and a median value of 301 (86 -301), the total biological air quality of fungi has an average value of 49.65±14.20 and a median value of 48 (25 -81).

In the bivariate results obtained the following results;

an average of 16.83 for those without respiratory allergies. PM2.5 was not associated with respiratory

Table 1. Univariate test

Variable	Unit	n (%)	Mean± SD	Median (min-maks)
Age		35 (100%)	49.42±13.11	50 (29-80)
Gender				
Man		13 (37.1%)	-	-
Woman		22 (62.9%)	-	-
Length of working	</> 5 Tahun	35 (100%)	0.80±0.40	1 (0-1)
Working duration	</> 8 jam	35 (100%)	0.42±0.50	0 (0-1)
Frequency of work	</> 3 kali	35 (100%)	0.62±0.49	1 (0-1)
Status		35 (100%)	0.42±0.5	0 (0-1)
Health				
Respiratory Allergies				
Indoor air Physical quality (Temperature)	(^{0}C)	35 (100%)	31.34±1.36	31.10 (29.40-34.30)
Indoor air Physical quality (humidity)	(%)	35 (100%)	63.74±4.16	65 (56-76)
Indoor air Physical Quality ($PM_{2.5}$)	(mg/m^3)	35 (100%)	19.05±25.84	14 (5-162)
Indoor air Physical Quality (PM_{10})	(mg/m^3)	35 (100%)	19.14±12.81	17 (0-88)
Indoor air chemistry (CO_2)	(Ppm)	35 (100%)	596.83±155.68	560 (329-1072)
Indoor air chemistry (TVOC)	(Ppm)	35 (100%)	0.50±0.75	0.2 (0.01-2.56)
Indoor air chemistry (HCHO)	(Ppm)	35 (100%)	0.46±2.47	0.01 (0.01-14.65)
Indoor air biological quality	(CFU/m^3)	35 (100%)	283.40±58.35	300 (86-300)

Based on the table above, the total bacteria were not associated with respiratory allergies where P, 0.430>0.05 with an average of 17.23 for the total bacteria with respiratory allergies and 18.58 for the total bacteria with no respiratory allergies. The total fungus was not associated with respiratory allergy where P, 0.333>0.05 with a mean of 19.93 for the total fungus with respiratory allergy and 16.55 for the total fungus with no respiratory allergy. PM10 had no association with respiratory allergies where P, 0.431>0.05 with a mean of 19.57 for PM10 with respiratory allergies and allergies where P, 0.093>0.05 with a mean of 14.73 for PM2.5 with respiratory allergy symptoms and 20.45 for those without respiratory allergies. Temperature was not associated with respiratory allergies with P, 0.880>0.05 with a mean of 31.39 for those with respiratory allergies and 31.32 for temperatures with no respiratory allergies. Relative humidity was not associated with respiratory allergies where P, 0.788>0.05 with a mean of 18.53 for those with respiratory allergies and 17.60 for relative humidity with no respiratory allergies. CO2 was not associated with respiratory allergies where P, 0.916>0.05 with a mean of 593.53 for CO2 with respiratory allergies and 599.30 for CO2 with no respiratory allergies. Formaldehyde was not associated with respiratory allergies where P, 0.748>0.05 with a mean of 18.63 for formaldehyde with respiratory allergies and 17.53 for formaldehyde with no respiratory allergies. TVOC was not associated with respiratory allergies where P, 0.064>0.05 with a mean of 21.70 for TVOC with respiratory allergies and 15.23 for TVOC with no respiratory allergies.

Based on the results of the multivariate test, the results obtained, men and 22 women. With the majority working as permanent farmers and only about 8 people working non-permanently because they were fishermen. The last education of farmers is about 19 elementary school graduates, about 10 junior high school graduates, and only 6 high school graduates. Each farmer has a duration of work ranging from 8 hours a day starting from PK 07.00 – PK 15.00 about three times a week about 22 people and 13 people who work less than three times a week. The farmers have worked as farmers for > 5 years about 28 people and for < 5 years about 7 people.

Table 2. Mann Whitney Test & T-Test between Respiratory Symptoms and Air Quality

Respiratory Symptoms	Yes	No	P
Total Bacteria	17.23	18.58	0.430
Total fungi	19.93	16.55	0.333
PM_{10}	19.57	16.83	0.431
$PM_{2.5}$	14.73	20.45	0.093
Temperature	31.39	31.32	0.880
Relative Humidity	18.53	17.60	0.788
CO_2	593.53	599.30	0.916
Formaldehis (HCHO)	18.63	17.53	0.748
TVOC	21.70	15.23	0.064

In the multivariate analysis table after the Binary Logistics Regression test was carried out on all variables with respiratory allergies, it was found that the air chemistry quality of TVOC was P,0.056 <0.1, which means that each variable had a significant effect, especially for TVOC. By having a weak risk factor for respiratory allergies with OR / Exp.B 0.345 > 1. Because the B value is negative, TVOC has a negative relationship with respiratory allergies.

Discussion

From the results of the study on a sample of 35 farmers in Pulokerto and Sungai Rebo areas, the majority of them were female compared to 13 samples of

In this case, the researcher takes a sampling of farmers because farmers bring seeds and harvests home, sometimes farmers bring home their rice fields and put them in the house. When checking the air quality in the house, the air quality checker is placed at the gathering point of the house where the family members gather. Most of the farmers' houses have narrow house areas, no ceilings, have several ventilations and windows that are opened every day. The residents of the house are also diligent in cleaning the house every day. However, as many as 6 houses do not have their own latrines, where residents of the house have to go to a public toilet if they want to defecate. Meanwhile, all the houses studied did not have waste water disposal facilities (SPAL), so that household waste was directly channeled under the house because their houses were built on wetlands that were always flooded and all the houses studied had temporary trash bins which would then be carried out. future burning. Of the 35 houses examined, 15 healthy houses were found and as many as 20 houses were included in the criteria for unhealthy houses.

From the results of the physical examination of air quality, PM10 has an average of 19.14±12.81 with the highest value of PM10 being 88.00 ppm, it was found in one house where the owner of the house was smoking inside the house and had storage for plowing tools such as tractors and the farmer had a workshop in his house so he put oil and tractor repair tools in the family room. The lowest value of PM10 is 10.00 ppm, where the house has ventilation and the windows are wide open so that when the inspection is carried out the house feels cool.

occupants of the house become dehydrated / heat stroke so that additional ventilation is needed so as to increase air circulation.

The results of the physical quality inspection of the relative humidity of the indoor air had an average of 63.74±4.16 with 31 houses having humidity exceeding the threshold, namely > 60%. This is because the majority of these houses lack good lighting other than wooden houses built on water which can increase the humidity of a house. In some houses farmers have pets such as chickens, ducks and cows which they put behind the house and almost every time the chickens go in and out of the house. As has been written by [4] that a house with insufficient lighting and ventilation will make the walls of the house feel damp which can then become weathered and can interfere with air quality in the house and can cause respiratory problems, and aggravated if you have pets that can cause allergens.

Table 3. Logistics Binary Test between Respiratory Symptoms and Air Quality

Symptom				
step	Respiration	B	Sig	Exp.B
Quality	No	-1.064	.056	.345
Air chemistry indoor	Yes			

The same results were obtained on physical air quality inspection of PM2.5 having an average of 19.05±25.84, the highest value obtained was 162 ppm found in a house where the farmer smoked and had the tractor workshop storage; the lowest value is 5.00 ppm. The remaining 34 samples had normal physical air quality. According to [9] opening windows, adding ventilation, or adding exhaust can help reduce airborne particulate matter levels in the room.

From the results of the physical examination, the room air temperature has an average of 31.34±1.36 with the lowest temperature being 29.40 ^oC and the highest being 34.30 ^oC. According to PMK 1077 the required level is around 18-30 ^oC, from the table there are 21 houses that have a temperature > 30 ^oC. because the house is arid without trees and the room is not too big, filled with goods and occupants who are quite dense. Temperatures that are too high can make the

The results of the chemical examination of Total Volatile Organic Compound (TVOC) have an average of 0.50±0.75, where from 35 houses the results are within normal limits, with the highest value of 2.5610 ppm and the lowest being 0.0080 ppm. This is because the wetland area where the farmers live is an area that is quite rarely traversed by motorized vehicles, besides that the farmers, including traditional farmers, do not always use pesticides / traditional farmers so there are no pesticides in the house. Farmers say that they use pesticides only in certain crops, but almost all of them use traditional methods. It is different with the results of the chemical examination of carbon dioxide (CO_2) which has an average of 596.83±155.68 with the lowest value of 329 ppm and the highest value of 1072 ppm. In this case, there is one house that has high CO_2 levels because the house is not too large and has a kitchen that is close to the family gathering point and their daily cooking uses firewood.

When sampling, the occupants of the house were cooking and the house only had 1 back door which was used as an air exchange in the kitchen without windows and ventilation. An increase in carbon dioxide in a friendly can identify a fairly dense number of occupants in a house that is not so spacious with minimal ventilation and windows. It is better to open all windows and back doors when cooking and direct the fan towards the window so that it helps the exhaust of combustion gases, but it is even better if you change wood fuel to gas and it is not aggravated by smoking inside the house or can maintain plants around the house. to reduce carbon dioxide levels in the house [9]. The results of the chemical formaldehyde (HCHO) examination have an average of 0.46±2.47 with the lowest value of 0.0070 and the highest value of 14.6570, where there are 3 houses with quite high scores, one of which is a house that has a repair shop for tractors, oil storage, and there are several houses. which is being renovated and then put the building materials in the house.

Based on the results of the biological air quality examination, an average of 283.40±58.35 was obtained where as many as 32 houses had bacteria results >300 CFU/m3 or about 91.4%, one house with a total of 103 CFU/m3 bacteria, one house with a total of 98 CFU/m3 bacteria , and one house had a total of 86 CFU/m3 bacteria. Houses that have a total bacteria <300 CFU/m3 because the house has a lot of open windows and a room that is not filled with goods and the occupants are 4 people, while for a house that has a total bacteria >300 CFU/m3 is a house that has windows but not always open and crowded house occupants. Usually the occupants of the house only open the door to make a place for air exchange. As stated by [9] that good air ventilation, open windows can help expel bacteria and particulate matter in the air.

Basically, an increase in particulate matter in the air can be related to bacteria in the air [10]. In addition, storing rice seeds in the house can also cause bacteria in the air and can increase particulate matter. Because rice seeds can produce dust particles that can be inhaled. From the results of the biological air quality examination, the fungus has an average of 49.65±14.20 where the lowest value is 25 CFU/m3 and the highest is 81 CFU/m3. According to PMK 1077 of 2011 both total bacteria and total fungi are only 0 CFU/m3 which is allowed.

Based on the results of research in 35 houses, the cause of bacteria and fungi that can grow in the house is a humid building with the majority made of wood that stands on a non-seasonal wetland area resulting in increased relative humidity levels, lack of ventilation for lighting and air exchange such as windows that are not always opened and only rely on the door of the house for air circulation, storage of seeds / rice seeds / crops in the house, entry and exit of livestock such as chickens and ducks, and storage of plowing equipment in the house which can increase particulate matter so that it becomes a place for growth fungi and bacteria. Humidity in a room accompanied by poor lighting and circulation can be a breeding ground for bacteria and fungi.

In the results of the bivariate analysis test between the variables total bacteria, total fungi, PM10, PM2.5, temperature, relative humidity, CO2, formaldehyde, and TVOC did not have a relationship with respiratory allergies that were linked one by one. This is because even though the air quality is not good where they live, they have a fairly good immunity because they are used to such an environment so that the body's homeostasis occurs. Meanwhile the house is directly adjacent to the wetland. According to [11] the ecosystem of a wetland can affect the climate and air exchange and the hydrological cycle of the surrounding environment, where the wetland ecosystem can clean the surrounding air itself. Meanwhile, the research area is a house that is directly adjacent to a wetland so that the wetland can purify the surrounding air so that the air inhaled by the farmers does not cause symptoms of respiratory allergies. Then the farmers already know the importance of using PPE, which according to [13] PPE is very important at work. All samples of farmers in the wetland area use PPE, at least masks, gloves, and boots.

4. Conclusion

The wetland area studied has health cadres who are quite active in helping local residents to check their health if they have symptoms of respiratory problems. If there is a respiratory allergy, this can be caused by things other than the air quality in the farmhouse, such as cold weather factors that can cause a person's hypersensitivity reaction to appear. In multivariate results when several variables were simultaneously associated with respiratory allergies, it was found that TVOC air chemistry had a significant effect on respiratory allergies with weak risk factors. Similarly, an unrelated bivariate analysis showed that respiratory allergies could be caused by things other than indoor air quality.

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References

[1]. Mamo, G. S. and Bekele, T. (2018) 'Review on Wetland Ecosystem Destruction', *International Journal of Scientific Research in Civil Engineering*, 2(January), pp. 4–15.

[2]. D'Amato, G. *et al.* (2016) 'Climate change and air pollution: Effects on respiratory allergy', *Allergy, Asthma and Immunology Research*, 8(5), pp. 391-395.doi:10.4168/aair. 2016.8.5.391.

[3]. Singh, A. B. and Mathur, C. (2021) 'Climate Change and Pollen Allergy in India and South Asia', *Immunology and Allergy Clinics of North America*, 41(1), pp. 33–52. doi: 10.1016/j.iac.2020.09.007.

[4]. Lévesque, B. *et al.* (2018) 'Impact of indoor air quality on respiratory health: results of a local survey on housing environment', *Public Health*, 163, pp. 76–79. doi: 10.1016/j.puhe.2018.06.015.

[5]. Mentese, S. *et al.* (2020) 'A long-term multi-parametric monitoring study: Indoor air quality (IAQ) and the sources of the pollutants, prevalence of sick building syndrome (SBS) symptoms, and respiratory health indicators', *Atmospheric Pollution Research*, 11(12), pp. 2270–2281. doi: 10.1016/j.apr.2020.07.016.

[6]. G, Maria; Catur, Y. et al (2015) 'Analisis resiko pajanan pestisida terhadap petani', *Jurnal Kesehatan Masyarakat*, 2(10), pp. 239–245.

[7]. Ye, M. *et al.* (2013) 'Occupational pesticide exposures and respiratory health', *International Journal of Environmental Research and Public Health*, 10(12), pp. 6442–6471. doi: 10.3390/ijerph10126442.

[8]. Berni, I. *et al.* (2021) 'Understanding farmers' safety behavior regarding pesticide use in Morocco', *Sustainable Production and Consumption*, 25, pp. 471–483. doi: 10.1016/j.spc.2020.11.019.

[9]. Piscitelli, P. *et al.* (2022) 'The role of outdoor and indoor air quality in the spread of SARS-CoV-2: Overview and recommendations by the research group on COVID-19 and particulate matter (RESCOP commission)', *Environmental Research*, 211 (January). doi: 10.1016/j.envres.2022.113038.

[10]. Andualem, Z. *et al.* (2019) 'Indoor bacterial load and its correlation to physical indoor air quality parameters in public primary schools', *Multidisciplinary Respiratory Medicine*, 14(1), pp. 1–7. doi: 10.1186/s40248-018-0167-y.

[11]. Salimi, S., Almuktar, S. A. A. A. N. and Scholz, M. (2021) 'Impact of climate change on wetland ecosystems: A critical review of experimental wetlands', *Journal of Environmental Management*, 286(February), p. 112160. doi: 10.1016/j.jenvman.2021.112160.

[12]. G, D. Ö. *et al.* (2018) 'Knowledge Level , Attitude , and Behaviors of Farmers in Çukurova Region regarding the Use of Pesticides', 2018.

[13]. Haleem Khan, A. A. and Mohan Karuppayil, S. (2012) 'Fungal pollution of indoor environments and its management', *Saudi Journal of Biological Sciences*, 19(4), pp. 405–426. doi: 10.1016/j.sjbs.2012.06.002.