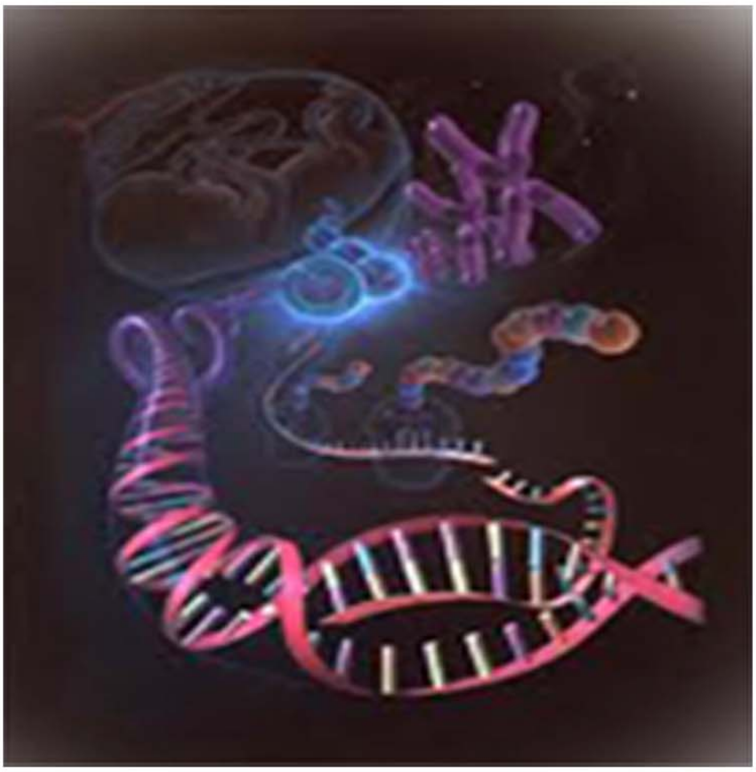
IJLBPR

ISSN 2250 - 3137
Vo1. 2, No. 1, January 2013

International Journal of Life Sciences Biotechnology and Pharma Research



www.ijlbpr.com

International Journal of Life Sciences Biotechnology and Pharma Research
Hyderabad, INDIA

Email : editorijlbpr@gmail.com or editor@ijlbpr.com

International Journal of Life Sciences Biotechnology and Pharma Research

ISSN 2250-3137 www.ijlbpr.com
Vol. 2, No. 1, January 2013

Research Paper

OPEN DEFECATION: A PROMINENT SOURCE OF POLLUTION IN DRINKING WATER IN VILLAGES

A V Rajgire[1]*

*Corresponding Author: **A V Rajgire,** diliptambekar@rediffmail.com*

Lack of adequate sanitation pollutes drinking water which most significantly due to open defecation and has series health impact on public. Water is one of the vehicles for the transfer of wide range of disease of microbial origin. Open defecation play an important role for polluting the ground water. Fecal pollution of water leads to introduction of variety of enteric pathogens that causes water borne diseases. Hence, analysis the effect of open defecation practices on bacteriological and chemical quality of drinking water in such a villages which is awarded 60% open defecation free (ODF) from Nirmal gram Puraskar scheme of Govt. of India and also the villages which is open defecation not free (ODNF) in Amravati District. From 138 villages (66 ODF and 72 ODNF); total 211 drinking water samples were analyzed for bacteriological and water quality Index (WQI). The results showed that drinking water in open defecation free villages was 17% fecally contamination whereas open defecation not free villages 48%. In both ODF and ODNF villages fecally contaminated drinking water samples was also showed poor water quality index (WQI) also TTC positive and E. coli detected by antibiotic resistance analysis. Thus, it clearly indicated that open defecation leads to contamination of ground water sources like open well, hand pump and tube well in villages. Provision of toilets to every household to control water is a useful means of attaining total sanitation.

Keywords: Enteric diseases, Water pollution, Physico-chemical, Bacteriological, Antibiotic resistant, TTC positive, *E. coli*

INTRODUCTION

Every living thing requires water for betterment of their health. Supply of clean, safe and potable drinking water to the community is utmost important in maintaining positive health measures. The drinking water must be free from pathogenic microorganisms. Water is, in fact, one of the vehicles for the transfer of wide range of disease of microbial origin. Many people in the world suffer from water borne diseases. Water receives microorganisms from air, sewage, soil and other organic wastes. Fecal pollution of water leads to introduction of variety of intestinal pathogens that causes water borne diseases (Jacobson and Lan, 1988). There are various religious practices that revolve around sources

[1] P G Department of Microbiology, Sant Gadge Baba Amravati University, Amravati 444602, India.

of water. Immersion of idols in surface water bodies is a prime cause of deteriorating water quality. Water bodies have been used as dumping grounds for various offerings that have degraded the potability of surface water. Defecation on boundaries of water bodies results in bacteriological contamination (Water Aid, 2011). Millions of people in many states in India are affected by waterborne diseases and a large number of them are in crippling stage and leading vegetative life (Tambekar *et al.,* 2008). According to WHO, about 600 million episodes of diarrhoea and 40,00,000 childhood deaths are reported per year due to contaminated water and lack of sanitation. An estimated 80% of all diseases and one-third deaths in developing countries are caused by consumption of contaminated water and on an average; one tenth of each person's productive time is sacrificed to water related diseases. Interventions in hygiene, sanitation, and water supply make proven contributors to controlling this disease burden. Improving access to safe drinking water can result in tangible improvements to health. Assurance of drinking-water safety is a foundation for the prevention and control of waterborne diseases (George, 2009, Tambekar *et al.,* 2010, WHO, 2010). Open defecation remains the predominant norm and poses one of the biggest threats to the health of the people in India. Estimates suggest that nearly 65 percent of India's population still defecate in the open. This results in a faecal load of 2,00,000 metric tons per day, which finds its way into soil and water bodies, contaminating them with pathogens (3RGNDWM, 2002-03). The practice of open defecation is reinforced by traditional behaviour patterns and lack of awareness about the health threats posed by it. At the same time, there is little awareness about the potential health and consequent economic benefits of sanitation facilities. This is a key causative factor behind the high prevalence of soil and water borne diseases in rural India (SSHE, 2004). Toilets and latrines that isolate and sanitise human excreta are necessary for a clean, healthy community living environment; they also safeguard overall ecosystem health by keeping biological pathogens from contaminating waterways and land. A direct relationship exists between water, sanitation, health, nutrition, and human well-being. Consumption of contaminated drinking water, improper disposal of human excreta, lack of personal and food hygiene and improper disposal of solid and liquid waste have been the major causes of many diseases in India and over 50 million people suffer from water born diseases annually and among 2 million die according to WHO (WHO, 1193). Hence, Government of India launched the Nirmal Gram Puraskar (NGP) scheme in Octomber 2003 for fully sanitized and open defecation-free Gram Panchayat (George, 2009). NGP is given to those "open defecation free (ODF)" Nirmal Gram Panchayat, Blocks, and Districts, which have become fully sanitized. A "Nirmal Gram" is an "Open Defecation Free" village where all houses, Schools and Anganwadis having sanitary toilets and awareness amongst community on the importance of maintaining personal and community hygiene and clean environment (NGP Guideline, 2010). Open defecation deteriorate the quality of drinking water, makes the water unfit for drinking purpose and enhances the chances of water borne diseases. The most important aspect of water quality is its freedom from contamination with faecal matter. The primary objective of bacteriological examination of drinking water is thus the detection of faecal pollution indicated by the presence of bacteria of faecal origin or from open defecation. The common sources of ground water are wells (open/ tube wells) and various routes may contaminate these natural sources of water. To avoid the spread of water borne diseases in the community and to ensure the safety of drinking water, the open defecation should be stopped and the regular water quality monitoring should be performed (Sobsey and Pfaender, 2002).

In villages of Amravati district, people use water from different sources like open well, tube well, hand pump and water supplied by Gram Panchayat for drinking and domestic use. This water may be highly contaminated by faecal matter, sewage, and domestic waste, which support the growth of various microorganism and cause epidemic diseases. Keeping in mind, attempt was made to analyze the effect of open defecation practices on chemical and bacteriological quality of water in open defecation free (ODF) and open defecation not free (ODNF) village in Amravati district and detection of source of contamination by antibiotic resistant analysis.

MATERIALS AND METHODS

Drinking Water Sample Collection and Inoculation: The drinking water samples were collected during 2011 to 2012 for physico-chemical and bacteriological quality analysis from the Nirmal Gram Puraskar awarded and above 60% open defecation free and also open defecation not free villages of Amravati district. Total 138 villages were selected in which 66 villages were from open defecation free and 72 villages were from open defecation not free scheme. Drinking water sample collected from the different sources like open well, tube well and hand pump. A total of 211 drinking water samples were collected, out of which, 104 from open defecation free (ODF) villages (66 villages), of which 45 from open well (OW) and 59 from tube well/ hand pumps (TW/HP) whereas 107 drinking water samples from open defecation not free (ODNF) villages (72 villages) in which 47 from open well and 60 from TW/HP. From this water supply approximately 20 ml water sample was taken and directly added into the H_2S medium contain bottle. These bottles were then incubated at room temperature for 24, 48 and 72 h to determine the extent of blacking in the bottle due to the reduction of ferric ammonium citrate by hydrogen sulphide gas produced. The bacteriological examination of water performed within 24 h of water collection using Manja's Modified H_2S rapid test (Manja *et al.,* 2001, Tambekar *et al,* 2008) and standard Multiple Tube Fermentation Technique (MTFT) for determination of Most Probable number (MPN) Index. The Manja's H_2S test performed by adding approximately 20 ml water sample into the Manja's H_2S medium contain bottle. These bottles then incubated at room temperature for 24, 48, and 72 h to determine the extent of blacking in the bottle due to the reduction of ferric ammonium citrate by hydrogen sulphide gas produced. The MPN was calculated by Multiple Tube Fermentation Technique (MTFT); nine multiple tube dilution technique using double and single strength Bromo-Cresol Purple MacConkey medium, by adding 10ml, 1ml, 0.1ml water sample in appropriate test medium and incubated for 24-48h at 37^0C. The MPN Index was calculated from MPN table and index of water more than 10coliforms/dl was designated as polluted or unhealthy for drinking purpose or non-potable (APHA, 1998).

Detection of Thermotolerant Coliforms: The presence of thermotolerant coliforms in the drinking water sample was detected by performing Eijkman test. Both H_2S and MPN positive test broth were further processed for detection of thermotolerant coliform (TTC) or thermotolerant *E. coli* by inoculating in Brilliant Green Lactose broth and Tryptone broth for indole test at 44.5^{0}C. The indole positive and gas formation in BGLB at 44.5^{0}C confirmed the TTC.

Antibiotic Resistance Analysis: Antibiotic resistance analysis of detected thermotolerant *E. coli* (45 strains) performed with Amoxicillin, Chloramphenicol, Ciprofloxacin, Cotrimoxazole, Gentamicin, Nalidixic acid, Nitrofurontoin and Norfloxacin by disc diffusion method and Antibiotic resistant Index were calculated for determination of source of faecal contamination (Tambekar and Charan, 2004, Kasper and Burgess, 1990).

Physico-Chemical Examination of Water: Colour, odour, taste, turbidity, pH, temperature, conductivity, TDS, Salinity, chloride, dissolved oxygen of water sample were determined on the spot by Kit supplied by Delhi based company Nayana and Phosphate, Nitrate by standard methods (APHA, 1998). Based on CCME, 2001 the water quality was calculated using software available on website (http://www.water-research.net/waterqualityindex.htm) (CCME, 2001). The statistical analysis performed with the Statistical Package for Social Sciences 19 for Windows (SPSS Inc.; Chicago, IL, USA) software.

RESULTS AND DISCUSSION

The most common and widespread health risk associated with drinking water is contamination, either directly or indirectly, by human or animal excreta and the microorganisms contained in faeces. Contaminated water can cause disease outbreaks including cholera, dysentery, hepatitis (often in rainy season in Mumbai) and cryptosporidiosis. A healthy living environment depends on toilets. Human waste enters water sources and land through open defecation, inadequate disposal into water courses and onto unused land, and leakage from pit latrines.

Worldwide, infectious diseases such as waterborne diseases are the number one killer of children under five years old and more people

Table 1: Rapid Manja's H2S and TTC test showed water quality of Open defecation free (ODF) and Open Defecation Not free (ODNF) villages

Type of Villages	Water source	No. of samples	Positive H_2S test			TTC positive
			24h	48h	72h	
ODF (66)	Open well	45	1 (2%)	21(47%)	22 (49%)	7 (15%)
	TW/HP	59	0 (0%)	8 (14%)	18 (30%)	1 (2%)
	Sub total	104	1 (1%)	29 (28%)	40 (38%)	8 (8%)
ODNF (72)	Open well	47	4 (6%)	30 (64%)	36 (77%)	23 (49%)
	TW/HP	60	1 (2%)	14 (23%)	22 (37%)	14 (23%)
	Sub total	107	5 (4%)	44 (41%)	58 (55%)	37 (35%)
Total		211	6 (2%)	73 (35%)	98(47%)	45 (21%)

Table 2: Quality of drinking water of different villages in correlation with H_2S test, physicochemical properties (WQI) and TTC

Types of villages	Water Source	H_2S Test 72 H	Water Quality Index	TTC		Total
				Positive	Negative	
Open defecation free Villages (ODF, 66 villages) (104)	Open Well(45)	Positive(22)	Poor	7	0	7
			Marginal	0	8	8
			Fair	0	6	6
			Excellent	0	1	1
			Total	**7**	**15**	**22**
		Negative (23)	Marginal	0	11	11
			Fair	0	11	11
			Good	0	1	1
			Total	**0**	**23**	**23**
	Tube well/ Hand pump (59)	Positive(18)	Poor	1	0	1
			Marginal	0	8	8
			Fair	0	9	9
			Total	**1**	**17**	**18**
		Negative (41)	Marginal	0	19	19
			Fair	0	17	17
			Good	0	4	4
			Excellent	0	1	1
			Total	**0**	**41**	**41**
Open defecation Not free Villages (ODNF, 72 villages) (Water Sample 107) Total Water Samples (211)	Open Well(47)	Positive(36)	Poor	23	1	24
			Marginal	0	7	7
			Fair	0	4	4
			Good	0	1	1
			Total	**23**	**13**	**36**
		Negative (11)	Poor	0	1	1
			Marginal	0	6	6
			Fair	0	4	4
			Total	**0**	**11**	**11**
	Tube well/ Hand pump (60)	Positive(22)	Poor	14	0	14
			Marginal	0	6	6
			Fair	0	2	2
			Total	**14**	**8**	**22**
		Negative (38)	Poor	0	1	1
			Marginal	0	14	14
			Fair	0	19	19
			Good	0	4	4
			Total	**0**	**38**	**38**

die from unsafe water annually than from all forms of violence, including war (WHO, 2002). Unsafe or inadequate water, sanitation, and hygiene cause approximately 3.1 percent of all deaths worldwide, and 3.7 percent of DALYs (disability adjusted life years) worldwide (WHO, 2002). Unsafe water causes 4 billion cases of diarrhoea each year, and results in 2.2 million deaths, mostly of children under five. This means that 15% of child deaths each year are attributable to diarrhoea – a child dying every 15 s. In India alone, the single largest cause of ill health and death among children is diarrhoea, which kills nearly half a million children each year (WHO and UNICEF, 2000).

According to India's 2011 census, nearly 50% population has no toilet at home, but more people (53%) own a mobile phone. More than 300 million people still defecate in the open in the South-East Asia Region. The excreta eventually contaminate surface water and groundwater. In Southern Asia, 63% of rural people – 778 million people – practice open defecation and 18% of the world's population, or 1.2 billion people (1 out of 3 in rural areas), defecate in the open. Open defecation significantly compromises quality in nearby water bodies and poses an extreme human health risk (UNICEF and WHO, 2008). Human waste enters water sources and land through open defecation, inadequate disposal via sewer pipes into water courses and onto unused land, and leakage from pit latrines. In Southeast Asia alone, 13 million tons of faeces are released to inland water sources each year, along with 122 million m^3 of urine and 13 billion m^3 of grey water. This presents a major health threat to people who depend upon open streams and wells for their drinking water.

For the study, a drinking water sample were collected during 2011 to 2012 for physico-chemical and bacteriological quality analysis from the Nirmal Gram Puraskar awarded and above 60% open defecation free and also open defecation not free villages of Amravati district. Total 138 villages selected for study, out of which 66 ODF and 72 ODNF. Out of 211 drinking water samples, 104 were collected from open defecation free (ODF) villages (66 villages), of which 45 from open well (OW) and 59 from tube well/ hand pumps (TW/HP) whereas 107 drinking water samples from open defecation not free (ODNF) villages (72 villages) in which 47 from open well and 60 from TW/HP.

The 104 drinking water samples from ODF

Table 3: Quality of drinking water of ODF and ODNF villages in correlation with H_2S test, physicochemical properties (WQI) and Multiple Antibiotic Resistance Index (MARI) of detected faecal *E.coli*

Type of village	Water source	H_2S test 72 H	Water Quality Index	Multiple Antibiotic Resistance Index (MARI)							Total
				31-40	41-50	51-60	61-70	71-80	81-90	91-100	
Open defecation free	Open Well (7)	Positive	POOR			4	2		1		7
Villages (ODF) (8)	Tube well/ Hand pump (1)	Positive	POOR			1					1
Open defecation not (37)	Open Well (23)	Positive	POOR	3	5	2	1	6	5	1	23
free Villages (ODNF)	Tube well/ Hand pump (14)	Positive	POOR	5	6	1	2				14

villages, includes 45 from OW and 59 from TW/HP; when analyzed with Manja's Rapid H_2S test, 49% water samples from OW and 30% of TW/HP were positive after 72 h of incubation. Out of these 45 from open well, one (2%) at 24 h, 21 (47%) at 48 h and 22 (49%) at 72 h were found to be contaminated by H_2S test. Out of these 22 drinking water samples, seven (15%) were found to be contaminated by thermotolerant coliform. Out of 59 water samples from TW/HP; (0%) at 24 h, 8 (14%) at 48 h and 18 (30%) at 72 h were found to be contaminated by H_2S test. Out of these 18 drinking water samples 1 (2%) found contaminated by thermotolerant coliform.

Out of 107 drinking water samples from ODNF villages; when 47 OW samples analyzed, 4 (6%) in 24 h, 30 (64%) in 48 h and 36 (77%) in 72 h were positive whereas out of 60 drinking water samples from TW/HP, 1 (2%) at 24 h, 14 (23%) at 48 h and 22 (37%) at 72 h were found to be contaminated by Manja's Rapid H_2S test. It means that these water samples were contaminated with coliform associated organism. When 72 h broth of H_2S positive test further analyzed for TTC by Eijkman test, it was found to be 49% and 23% polluted with thermotolerant coliform from open well and tube well/ hand pump respectively.

The water from ODNF villages found to be 35% contaminated as compared to 8% of ODF villages. When we compared the water quality of OW with TW/HP, it observed that OW in ODNF found to be contaminated 77% by H_2S and 49% by faecal coliforms as compared to 49% with H_2S and 15% with TTC in OW from ODF.

In case of tube wells 30% and 2% were polluted by total coliform and faecal coliforms respectively in ODF as compared to 37% and 23% in ODNF water samples thus it indicated that water from open wells was almost 50% contaminated in ODNF as compared to 15% to ODF. It showed that the open defection pollute or contaminate the OW more as compared to TW/HP water. It also showed that TTC was more in ODNF villages as compared to ODF village's water.

The results showed that drinking water in open defecation free villages was 83% free from faecal contamination and ODNF villages were 52%. Thus, it indicated that open defecation was one of the most important factors for polluting the ground water sources such as open well, hand pumps, and tube well. All the water samples having very poor water quality index (WQI) were TTC positive. It clearly showed significant correlation between WQI and presence of thermotolerant coliform in drinking water. Thermotolerant coliform did not detected in any of the water samples with marginal, fair, good, and excellent quality of drinking water. It clearly showed that open defecation in rural villages deteriorates the water quality and faecal *E. coli* was detected in water samples with poor water quality. When antibiotic resistance index for detected *E. coli* were calculated it is higher side in ODNF villages as compared to ODF villages. It clearly indicated that the contamination in ODNF villages was mainly due to human faecal origin. The overall study showed that open defecation practices in rural India enhanced deterioration and polluted the drinking water. Therefore the project showed that prohibition of open defecation or making a village "Nirmal Gram" prevents the pollution in drinking water and also can make the village population free from diarrhoea, cholera, typhoid and other enteric infections, which will helpful in improving sanitation. Better sanitation not only improves human health but also promotes economic and social development.

CONCLUSION

However, the country will miss its 2017 target for achieving total sanitation coverage as the government today said that it would take at least 10 more years before all villages can boast of "Nirmal Gram Panchayat" status and completely eradicate the practice of open air defecation. In the present study the open defecation not free villages the drinking water sample were found to be 55% contaminated with coliform associated organism and 35% found to be contaminated with thermotolerant coliform while in the open defecation free villages the drinking water sample were found to be 38% contaminated with coliform associated organism and 8% found to be contaminated with thermotolerant coliform. Hence, the percentage of contamination was more in open defecation not free villages, thus it conclude that open defecation was one of the most responsible factors that to leads more contamination of drinking water samples. Hence, unhygienic practices must be stopped to prevent spread of faeco-oral diseases among human beings due to contaminated water.

REFERENCES

1. APHA (1998), "Standard methods for the examination of water and wastewater", 17th edition, American Public Health Association, Washington D. C.

2. Canadian Council of Ministers of the Environment (2001), http://www.water-research.net/watr qualindex/waterquality index.htm.

3. George B (2009), "Nirmal Gram Puraskar: A unique experiment in incentivizing sanitation coverage in rural India", *International Journal of Rural Studies*, Vol.16, No.1, pp. 32-35.

4. Jacobson G and Lan IE (1988), "Cited in Australia ground water systems under stress", *Water Quality Bulletin*, Vol. 13, pp. 107-116.

5. Kasper C W and Burgess J L (1990), "Antibiotic resistance of *Escherichia coli* to identify source of fecal contamination in water", *Canadian Journal of Microbiology*, Vol. 36, pp. 891-894.

6. Manja K S, Sambasiva R, Chandra S K V, Nath K J, Dutta S, Gopal K, Lyengar L, Dhindsa SS and Parija SC (2001), "Report of study on H_2S test for drinking water", UNICEF, New Delhi.

7. Nirmal Gram Puraskar Guideline (2010), Government of India, Ministry of Rural Development Department of Drinking water supply, pp. 1-7.

8. Rajiv Gandhi National Drinking Water Mission, GOI, 2002-03 and WSP-SA, India.

9. School Sanitation Hygiene Education Global Symposium (2004), "Construction is not enough", Delft, The Netherlands 8-10 June.

10. Sobsey M D and Pfaender F K (2002), "Evaluation of H_2S method for detection of faecal contamination of drinking water", Geneva, WHO/SDE/WSH/02.08.

11. Tambekar D H and Charan A B (2004), "Antibiotic sensitivity indexing of *Escherichia coli* to identify source of fecal contamination in drinking water in Purna

valley Vidarbha", *Nature Environment and Pollution Technology*, Vol. 3, No. 3, pp. 413-418.

12. Tambekar D H, Hirulkar N B, Kalikar M V, Patil Y S and Gulhane S R (2010), "Prevalence of Thermotolerant *Escherichia coli* in drinking water and its Multidrug Resistance", *Research Journal of Microbiology*, Vol. 5, No. 11, pp. 1180-1184.

13. Tambekar D H, Wankhade S J, Yadav S D and Tambekar S D (2008), "Correlation of antibiotics resistance profiling of *E. coli* and source of fecal pollution in water", *Pollution Research*, Vol. 27, No. 3, pp. 507-510.

14. UNICEF and World Health Organization (2008), "Joint Monitoring Programme for Water Supply and Sanitation, Progress on Drinking Water and Sanitation: Special Focus on Sanitation", UNICEF, New York and WHO, Geneva.

15. URL: www.wateraid.org [cited on 24th Dec, 2011].

16. World Health Organization (1993), "Guideline for Drinking Water Quality", *World Health Organization*, Geneva, Vol. 1, 2nd Edition.

17. World Health Organization (2002), "World Health Report: Reducing Risks, Promoting Healthy Life", France, http://www.who.int/whr/2002 /en/whr02_en.pdf.

18. World Health Organization (2010), "Drinking water quality in the South-East Asia Region", *WHO*.

19. World Health Organization and United Nations Children's Fund (2000), "Global Water Supply and Sanitation Assessment 2000 Report", WHO and UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

International Journal of Life Sciences Biotechnology and Pharma Research
Hyderabad, INDIA. Ph: +91-09441351700, 09059645577
E-mail: editorijlbpr@gmail.com or editor@ijlbpr.com
Website: www.ijlbpr.com

ISSN 2250-3137