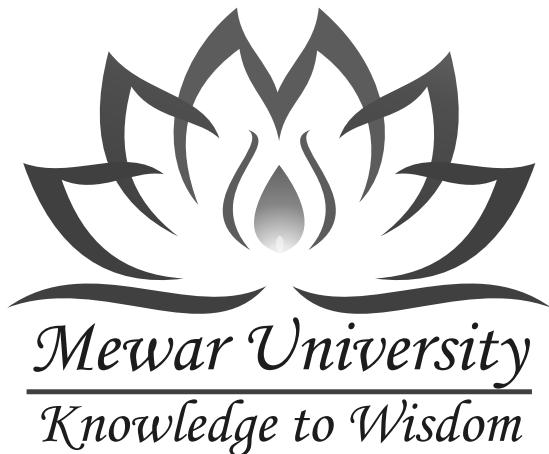




**JOURNAL
OF
INDIAN RESEARCH**



Mewar University

Journal of Indian Research

A Quarterly Journal of Multidisciplinary Research

Volume 7 || Number 4 || October-December-2019 || ISSN : 2321-4155

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Cover Design : Manishankar

Image Source: Katie Wohl. Website: https://society6.com/product/conspicuous-consumption-2w7_print

Publisher : Mewar University, Gangrar, Chittorgarh, Rajasthan

Printer : M.K. Printers, 5459, New Chandrawal, Kamla Nagar, Delhi-110007

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CHAIRPERSON'S MESSAGE

I, on behalf of Mewar University, wish the research scholars and the wider academic community a great new year ahead. The start of the year has witnessed tumultuous events. Climate change has become a reality. The report of the warming of the Antarctica clearly points to a dystopian future for several coastal belts. The melting of ice would cause many low islands to completely submerge and disappear. South Asia might witness such a scenario in Maldives and Laccadives. The forest fire in Australia was severe in magnitude. Such extreme events are turning out to be recurrent. Depletion of biotic resources is observed both in marine and mountain ecology. Forests are increasingly facing the land use pressure. Loss of forest habitat would be death knell to several species of plants and animals.

Climate change has also brought to the fore hitherto unknown microorganisms. Last year, it was the deadly Nipah virus that caused panic in India. This year COVID-19 is threatening the public health system globally. Bats are reservoir of several of these deadly viruses. While bats are losing their habitat and humans have come in close contact with their habitat, germs have mutated and made bat to human transmission possible.

Study of impact of climate change brings together climatologists, mathematicians, biologists, population experts, epidemiologists, sociologists, policy makers at one platform. It is the vibrant exchange of ideas that can pave way for an integrated management of ill-effects of climate change. Research scholars can no longer assume to be working in silos. They have to be conversant with the trends in frontiers of research of other disciplines.

Journal of Indian Research fulfils similar need where we are trying to introduce research works of different disciplines at common platform.

I hope the current issue would provide powerful insights to scholars of different disciplines.



Dr. Ashok Kumar Gadiya
Chairperson,
Mewar University

EDITORIAL

There have been spurt in rolling out 5 G mobile network across the world. It is the fifth generation of wireless communications technologies supporting cellular data.

While 1G technology facilitated us with communication of texts through wireless communication (radio pager), 2G technology made it possible to have mobile homes when we could use text and voice without wired connection. 3 G facilitated communication through text, voice and image. 4G has better network speed and one can also send videos. The higher the frequency, the faster the information can be transmitted. 4G and LTE use less than 6 GHz frequency range. 5G promises greater speeds and more bandwidth with upto 100 GHz frequency. In February this year, Doctors at West China Hospital of Sichuan University started using 5G technology to diagnose COVID-19 patients in Sichuan Province and further expanded diagnostic and treatment services to patients in Wuhan, which is 1,155 kilometers (718 miles) away.

5G is going to revolutionize the world. For smart cities, smart machines and smart traffic, this would be the optimal technology. 5G would support customized delivery of consumer items, as also make possible experience of augmented reality. This would herald the era of autonomous vehicles and the Industrial Internet. 5G is the base technology for the Internet of Things (IoT), where machines communicate with machines (M2M communication) without any need for human interference. Theoretically, molecules in universe can be turned into IoT devices. This would require high frequency wifi signals, which cannot be supported by current 4G or LTE. 5G would be the basic soft-structure for operation of a world full of IoT devices. Debate about such high frequency signal over human epithelial cells, environment, insects, plants and our organs have still not been settled.

But, before we could grapple with this world-changing IoT, we are staring at the future of Internet of Bio-Nano Things (IoBNT). Researchers have come up with the idea of using microbes as IOT devices. They want to use bacteria as effective sensor network at nanoscale. DNA built into bacteria can function as a control unit for processing and storing data whereby Digital –to- DNA and DNA- to- Digital translation of information can be done.

Next step which is being worked is sensorizing the biological matter. Already nano-scale sensors have become possible. A virus has a diameter of ~100 nano metre. That means mankind has technology to fit sensors even in viruses. Though, next attempt is on DNA/RNA-computing. Within our bodies, IoBNT system is a possibility which too can operate only when high frequency wi-fi signals like 5G is available. And unlike the chips, these bio-chips would be mobile, akin to propulsive chips. If wifi technology freed us from the stationary telephones and handed us mobile phones, 5G can make possible currently stationary chips mobile by marriage of biology and electronics.

Nano-sensors can be inserted inside our bodies for global digital identity or inserted in machine tied to our body. Through 5G technology, control and command can also be given

to the nano-sensors inside body. These sensors can monitor our biochemical dynamics at molecular level, neuronal spikes and all the complex parameters. By pattern recognition, big data can be generated on correlations of molecular dynamics and human thinking/action. Algorithm can be developed and thence the reverse control can be performed within our bodies.

Shift from biometric identity to digital identity is what has recently been proposed by technocrats in the US. IoBNT would make that possible. A brave new world of algorithmic supremacy lies ahead. Social sciences ought to grapple with the impact of these gigantic developments in technology.

It is the young researchers who have to shoulder the responsibility to rescue humanism from dogma of technical perfection. Millions of new flowers have to bloom. Let each of us inculcate the virtue of wandering creative mind!!

Niraj Kumar

Honorary Editor

EXAMINING THE DETERMINANTS OF CONSPICUOUS CONSUMPTION IN INDIA: A CONCEPTUAL FRAMEWORK AND EMPIRICAL EVIDENCE

*Deepika Kandpal**

ABSTRACT

India has recently experienced shifts in the consumption behavior. Conspicuous consumption, i.e. consumption with the purpose of showing off, has become an important part of life in developing as well as developed countries. People imitate the consumption choices of individuals at the top of the status hierarchy to adopt what French sociologist Pierre Bourdieu termed as "habitus". This paper analyses the factors affecting the consumption patterns in India, using a conceptual framework and household level data. The focus of the paper is the allocation of the budget between conspicuous and non-conspicuous goods in India. We explore large scale secondary data for the year 2011-12 to quantify the extent to which the budget choices for clothing, footwear, and social functions depend upon the household traits. In order to indicate the trade-off, we compare the budget allocation between conspicuous goods, i.e. clothes, footwear and social functions, on one hand and non-conspicuous goods, i.e. food and health, on the other. We find that certain groups tend to substitute spending on essential items by buying luxury goods. In particular, the evidence suggests that gender, marital status, education, geographical location, and social identity determine the demand for conspicuous goods and concerns for status. The paper provides important insights to the researchers, policy makers and marketing managers.

Keywords: Conspicuous spending, Consumerism, India, Social identity, Social status.

INTRODUCTION

Many developing countries have experienced a wave of consumerism with the onset of globalisation. India has also witnessed a marked increase in consumer oriented tendencies because of an active advertisement environment, availability of a variety of manufacturing products and globalisation. (Venkatesh, 1994). The symbolic consumption of luxury goods

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is a reaction to the wealth and status inequalities persistent in India either because of the differences in ability (meritocracy) or differences in wealth (aristocracy) (Chaudhuri and Majumdar, 2006). As a result, India is transcending from a caste-based society to a class-based society (Venkatesh, 1994). The consumption expenditure has an important implication on the growth patterns as it forms a major part of the aggregate demand. The study of the specific component of consumption, i.e. the expenditure on conspicuous items, is crucial because it reflects wasteful expenditure. In this way, the allocation of resources towards unproductive use is responsible for hindering human capital accumulation. Indian society, due to its diverse and complex nature, offers an interesting background to study the consumption patterns for conspicuous goods. In this paper, we investigate the interplay between conspicuous consumerism and household traits in India, using a large scale nationally representative data. We examine how status attainment is the motive for conspicuous consumption. On the basis of the literature on the consumption of status conveying good, we develop a conceptual framework to understand the relationship between socio-economic and demographic features, and consumerist approach. Next, we quantify the associations developed in the conceptual model using secondary data.

STATUS AND CONSPICUOUS CONSUMPTION

The study of consumption for deriving status originated with the works of Veblen (1899). Conspicuous consumption is defined as the consumption of items that are extravagant and luxurious (Campbell, 1995). This notion is now widely acknowledged among sociologists, economists, psychologists, and biologists. Conspicuous consumption serves as a means to earn respect or prestige among peers in society (Amaldoss & Jain, 2005). Hence, it is consumed not only by rich sections who can easily afford it but also by the poor individuals in an attempt to emulate wealthy people. The wasteful expenditure may reduce the resources available for human capital accumulation (Moav and Neeman, 2012). Driving the allocation away from conspicuous goods or reduction in status-seeking attitudes has the potential to generate social benefits.

Individuals can use the consumption of luxury and visible goods to indicate higher social standing. Valuable goods such as cars, branded clothes, watches, etc are used to symbolise status. Evidence suggests that people's decisions are shaped by positional concerns in the peer group (Luttmer, 2005; Heffetz and Frank, 2011). The theoretical models have considered the relevance of status goods for signaling (Ireland, 1994; Glazer and Konrad, 1996; Bagwell and Bernheim, 1996; Moav and Neeman, 2012) and positional concerns (Frank, 1985; Hopkins and Kornienko, 2004). People may care about social standing for a variety of reasons. Preferences for status may be hardwired in human psychology or a part of evolutionary preferences (Fershtman and Weiss, 1998). On the other hand, the concerns for status may arise due to the benefits bestowed by it.

Chaudhuri and Majumdar (2006) document the history of the culture of conspicuous consumption in western societies and India. They claim that the practice of exhibiting success was prevalent in primitive feudal societies among Romans and ancient Polynesians, primarily through the display of servants, food, clothing, and housing. Moreover, the culture of signaling

social rank is not new to India. It can be traced back to the 19th century when the “*nouveau riche of the city of Calcutta used to spend obnoxiously huge sums of money on grand feasts, betting, musical extravaganzas, brothel visits, and other showy yet meaningless events*” (*ibid*).

LITERATURE REVIEW AND CONCEPTUAL MODEL

Conspicuous consumption is argued to be relevant to attract mates with desirable traits. De Fraja (2009) claim that the mechanism of sexual selection during evolutionary times has led to signalling decisions by men. Women, on the contrary, may spend higher amounts on signalling because of greater dependence on others (Meyers-Levy, 1988). Hence, gender is expected to determine the consumption choices in either way. However, the empirical evidence suggests that mating choices affect the conspicuous consumption decisions of only men. Griskevicius *et al.* (2007) conducted experiments to investigate the relationship between conspicuous consumption and mating goals among men and women. They found that the inducement of mating goals among males increased their expenditure on luxury items. Furthermore, it did not affect the consumption choices of women. Segal and Podoshen (2013) find a significantly higher tendency of men to engage in materialism and conspicuous consumption, in a survey of American students.

There is a growing literature that recognizes the importance of the implications of ethnic identity on household decision making. Hanna *et al.* (2015) find substantial differences in financial behavior between Whites and Asian households in the US. Previous studies have also found differences in risk tolerance and saving behaviour across races or ethnic groups (Coleman, 2003; Yao *et al.*, 2005; Fisher and Hsu, 2012). Fan and Zuiker (1998) provide empirical evidence of higher budget allocation by Hispanic households as compared to their non-Hispanic White counterparts on necessity goods such as food at home, shelter, and apparel. Another study (Fontes and Fan, 2006) conducted in America finds a higher allocation of the budget on housing by Asian American households.

We also expect the education level of decision makers to influence the attitudes towards consumption items. Educated households are observed to be moving away from conspicuous goods to sophisticated items to exhibit wealth. Mason (1981) notes that with development, society moves towards a more subtle way of signalling status, such as education. Single individuals may choose to assign higher budget on ostentatious spending to attract a wealthy or attractive mates. On the other hand, the household where the head is married may care more about social status because of wider social circle. Hence, we expect that the marital status and education of the head of the household or the decisive member alter the choices of expenditure on conspicuous and non-conspicuous items.

The geographical location of a household is also expected to determine its consumption set. In rural regions, there is high familiarity among the neighbours because of low in-migration. This implies that the need to signal social status is low. Due to growing exposure to national and international brands, especially among the young consumers, the consumerism specific to luxury goods is growing in urban parts of India. High disposable income and greater exposure to mass media makes urban regions a better market for conspicuous goods. As a result, we expect the consumption decisions of the households to alter across the regions of residences

as well.

Based on the literature on luxury goods and consumption theory, we expect that the share of expenditure on conspicuous goods depends upon the following household level features: gender, marital status, education, the geographical location and religious identity.

DATA AND METHODOLOGY

The data used in this study comes from a sample of households in India, *Indian Human Development Studies-II*. It is collected and provided by NCAER and the University of Maryland. IHDS-II is a nationally representative survey conducted across 1503 villages and 971 urban neighbourhoods in 2011-12. We have used data only for those households where the estimated income is positive and the head of the household is between 18 and 65 years of age. We also drop the households with annual income and annual expenditure exceeding Rs 10,00,000. This leaves us with the data on 35,425 households. Based on the literature, we define conspicuous consumption as the expenditure on clothing, footwear, and social functions.

SAMPLE

The summary statistics of the sample described above is presented in Table 1. We use the household weights provided in the data to calculate weighted average of the characteristics. Around 70% of the sample is rural. Approximately 4/5th of the survey respondents are married. The Table also reflects the occupational distribution of our sample. Around 1/3rd of the households are cultivators or agricultural labourers. The sample also provides a fair representation of households working in organised sector as salaried workers, and unorganised sector. The data includes 20% upper caste (General and Brahmin) households whereas the remaining 70% belong to the marginalised sections, i.e. OBC, SC and ST categories. Also, there are around 80% Hindus, 12% Muslims and 2% Christian households in the sample. The remaining 2% are Sikh, Jain, Buddhist, and others. One-third of the sample households have illiterate head, whereas only 7% have graduate or post-graduate degree. We also find that on an average, these households earn and spend Rs. 1,04,341 and Rs. 1,04,680 (annually), respectively.

Table 1: Descriptive Statistics of the Sample

	Variable	Number of households	Percentage of households
Geographical Location	Rural	24,044	67.87
	Urban	11,381	32.13
Marital Status	Married	29,147	82.28
	Other	6,278	17.72
Gender	Male	30,390	85.79
	Female	5,035	14.21

Income source	Cultivators	8,424	23.79
	Agricultural wage labourers	4,231	11.95
	Non-agricultural wage labourers	8,967	25.32
	Petty shop/Artisan etc.	5,641	15.93
	Salaried	7,234	20.43
	Others	917	2.59
Caste	Forward	8,884	25.08
	OBC/SC/ST	26,540	74.92
Religion	Hindus	29,372	82.91
	Muslims	4,067	11.48
	Christians	794	2.24
	Others	1,193	3.37
Access to Maximum Education	Illiterate	11,779	32.55
	Below Primary	3,617	9.99
	Primary	3,269	9.03
	Middle	8,399	23.21
	Secondary	4,290	11.85
	Higher Secondary	2,249	6.21
	Graduate	1,745	4.82
	Post-graduate	842	2.33

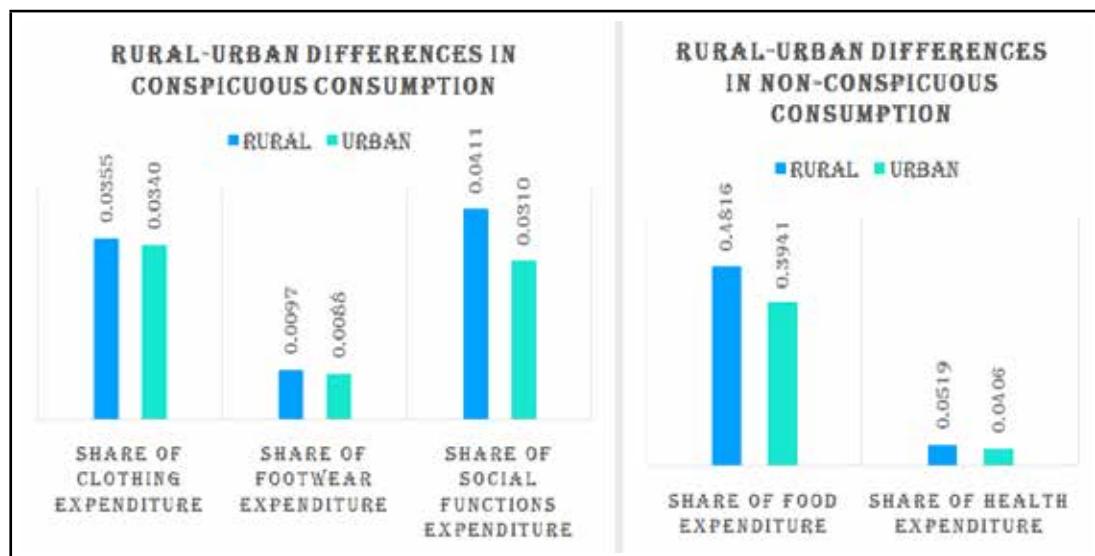
RESULTS AND DISCUSSIONS

People flaunt their social status by using branded and expensive clothing, footwear items and spending on social functions such as weddings and funeral. Table 2 presents the expenditure on conspicuous and essential items by the sample households. We find that, of the three luxury items considered in our study, the expenditure is highest on social functions, followed by clothing and footwear. Although the expenditure is lower than the consumption of food items, the spending on social functions is quite comparable to the annual expenditure on health. This shows the tendency of Indian households to spend extravagant amounts on the celebrations, even though the expenditure on human capital such as health is not very high. On an average, each household in our sample spends around 3% of its income on clothing. The share spent on footwear and social functions is approximately 1% and 4% respectively.

Table 2: Annual weighted expenditure on conspicuous and essential items (in Rs.)

Variable	Mean	Std. Dev.
Clothing	3364.994	3609.281
Footwear	886.0357	944.8311
Social Functions	5658.033	27532.88
Food	39534.54	21009.36
Health	6266.687	22080.38

We observe that the households residing in urban regions spend significantly higher amount on all the conspicuous items. However, their expenditure is also higher for non-conspicuous goods. The differences in the absolute expenditure may arise because of higher expenditure or income by urban households. In order to further investigate this, we control for the total expenditure by comparing the share of expenditure on these items. The results are presented in Figure 1. It is intriguing to note that rural households in fact pay larger share of their expenditure on clothing, footwear, and social functions, as compared to urban households. Nevertheless, they also allocate higher amount to the consumption of food items and health related expenditures.

**Figure 1: Rural-urban differences in consumption behavior**

In agreement with the conceptual framework, we find that consumption patterns vary across households with different marital status of head. We compare the consumption pattern between the households headed by married and others (unmarried, widowed, separated/divorced, spouse absent) in Figure 2. It is found that the percentage of expenditure spent on clothing and social functions is significantly higher for households in which the head decision-maker is married. These households spend a lower amount on essential items such as food and health care.

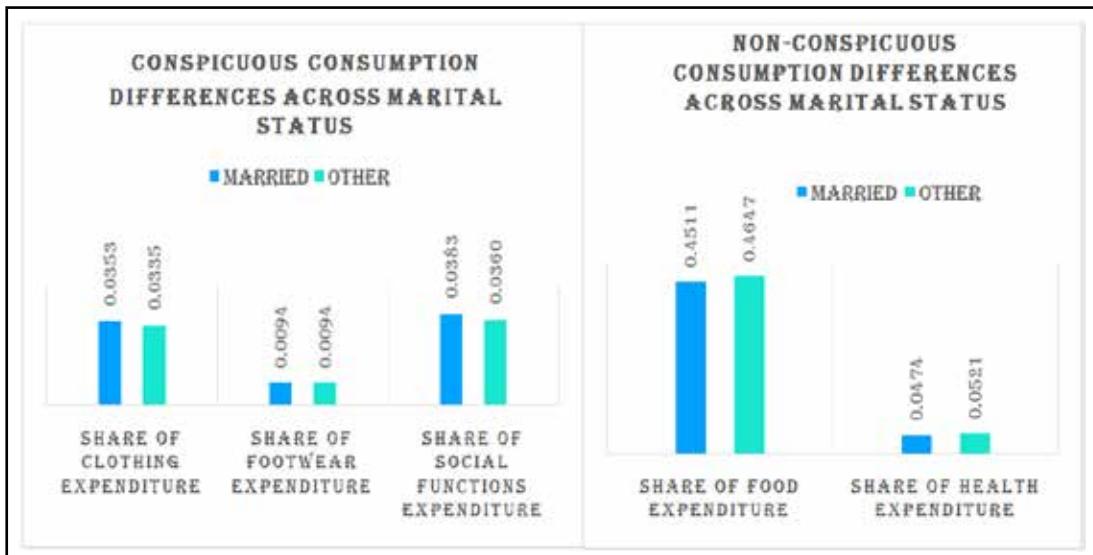


Figure 2: Consumption pattern between across marital status of the household head

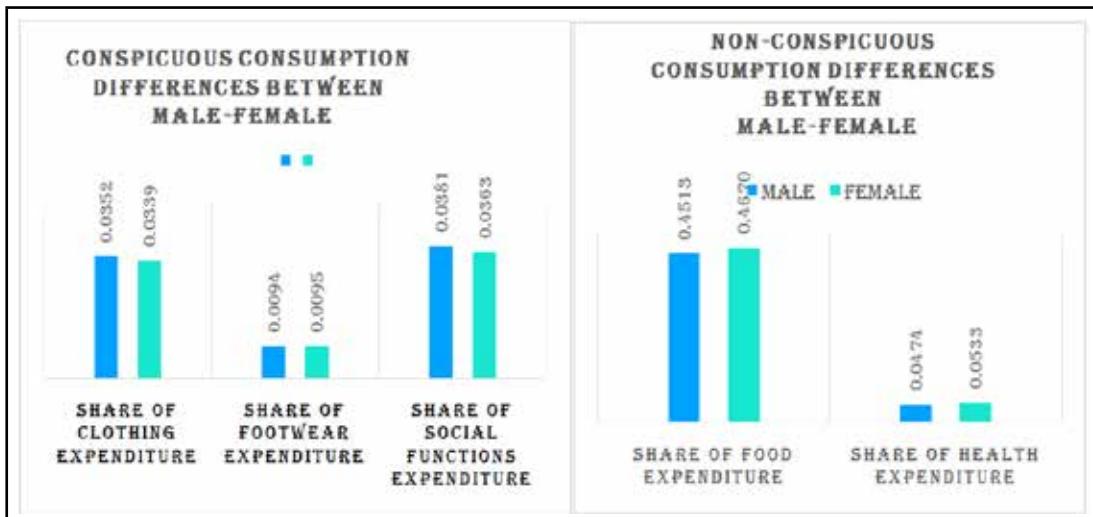


Figure 3: Gender differences in consumption patterns

Figure 3 presents the differences in spending between male and female household heads. We notice that the households headed by male members allocate larger budget share on clothing and social functions, and lesser on food and health.

Furthermore, the prevalence of ostentatious consumption may differ across countries and religious groups due to the differences in cultures and tradition. We observe that conspicuous spending differs across religious groups (Figure 4). Muslims spend a bigger share on clothing and footwear than Hindus, whereas the budget allocation on social functions is higher among the Hindus.

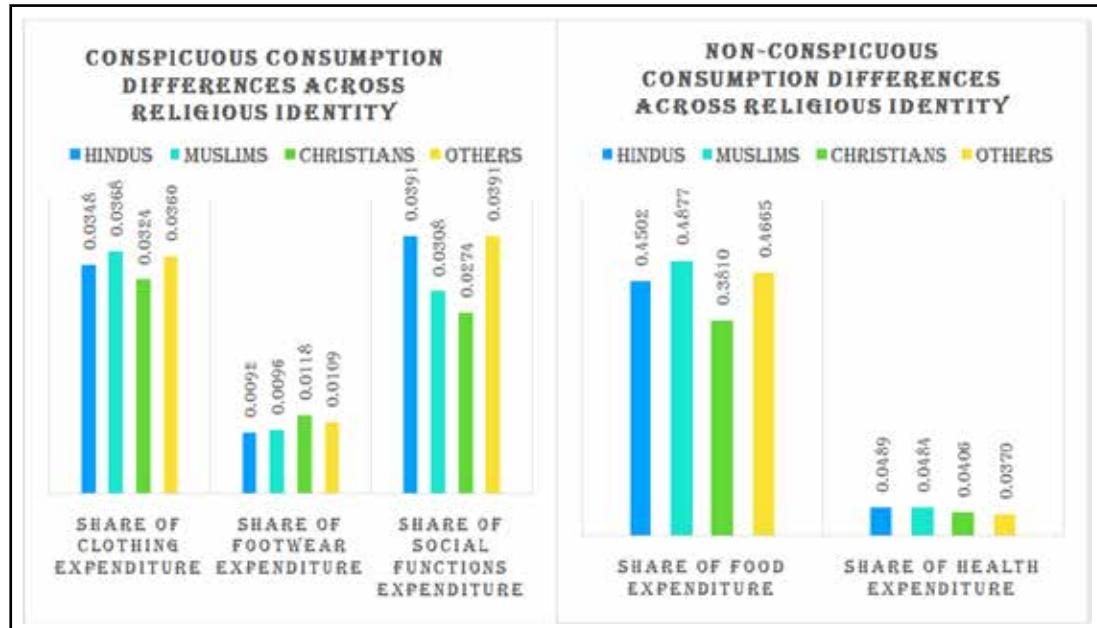


Figure 4: Consumption patterns across religious groups

Our data suggests a substantial connection between consumerism and household education level. The households where the highest educated member is graduate or above choose to spend a significantly lower amount on conspicuous goods. This is in line with our conceptual framework.

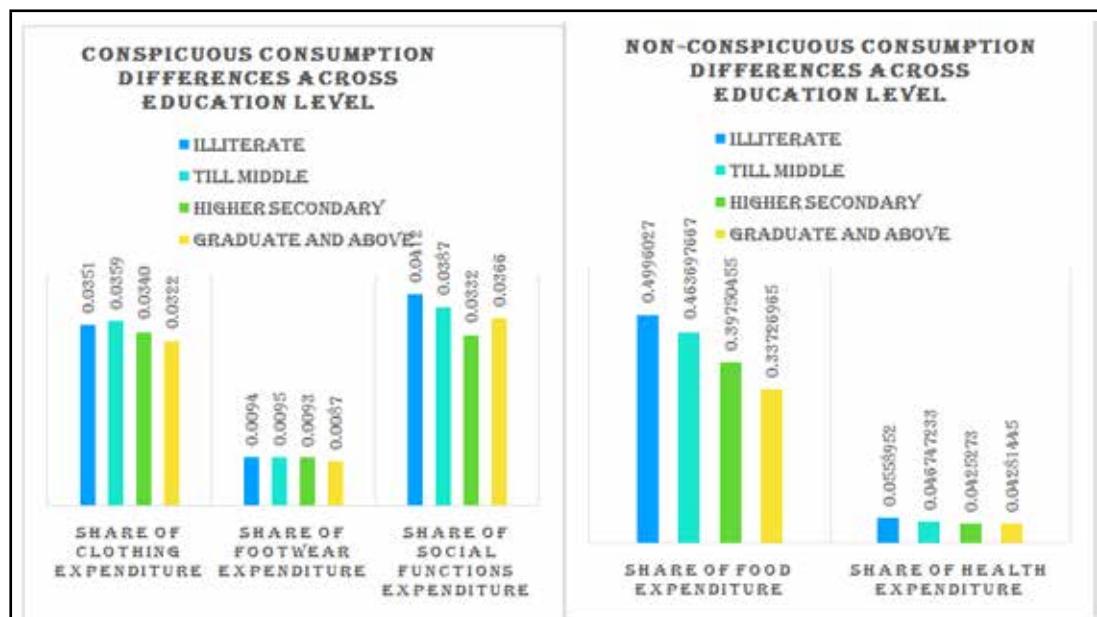


Figure 5: Consumption patterns across highest education level

Our results hint that the status concerns are stronger among households where the head of the house is married, male, and belongs to the disadvantaged section. These households are found to shift away from consumption of essential goods to the consumption of items required for conveying status. Religious group and culture also perform a vital role in determining the budget allocation. The higher spending by Muslims on clothing and footwear is indicative of compensatory consumption. On the contrary, greater spending by Hindus on social functions is reflective of cultural differences. The results from the survey support our conceptual framework. The characteristics of the head of the household such as marital status, gender, social and religious identity determine the spending on conspicuous and non-conspicuous items. The geographical location of the household is also important in influencing consumption patterns. Also, having a highly educated member in the house dictates the consumption choices in a constructive manner.

HIGHLIGHTS OF SURVEY

- Consumerism is rising in Indian society.
- Expenditure on branded clothing, footwear and celebrations is used by people to move up the status hierarchy.
- Rural households spend considerable amount on social functions.
- Married and male household heads are concerned more about status.
- Hindus devote significantly more than Muslims on social functions.

Note: The author declares no conflict of interest.

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DIVERSITY OF WATERBIRDS IN TAUDAHA LAKE, KATHMANDU, NEPAL

*Praveen Kumar Jha**
*Chetan Kumar Sharma***

ABSTRACT

*Diversity of waterbirds in Taudaha Lake was carried out during 15 - 20 January 2019. Point-count method was used to observe the bird diversity in the Taudaha Lake. In total, 16 species of birds belonging to 5 Orders and 5 Families were recorded. Among them Common Teal (*Anas crecca*) was the most abundant species. During the observation, Anseriformes (10 species) was the dominant Order but the dominant Family was Anatidae (10 species). In the present study, results show that 3 species were residents and 13 species were winter visitors. It was noted that there is a general decline in the number of wetland birds due to several factors such as lack of fringing vegetation and human interventions.*

Keywords: Birds, diversity, Nepal, Taudaha Lake, waterbirds.

INTRODUCTION

It is an established fact that wetland birds vouch for the most important conservation concern. Waterbirds are the key components of the wetland biodiversity in the world (Davidson & Delany, 2000). A total of 886 species of birds has been reliably recorded in Nepal (BCN & DNPWC, 2018). As many as 193 species of birds are considered heavily dependent on wetland habitats (Chhetry, 2006). Considering the scene of Nepal, twelve species of wetland birds are listed globally threatened due to their habitat loss and 44 species of wetland birds are declared threatened at national level for the reasons of habitat damage and loss, polluted water, fish poisoning, hunting, trapping, shortage of food due to over fishing, and also the destruction of feeding and nesting sites (Baral, 2009; BCN & DNPWC, 2011). Out of this, about 70% or two third of the total Nepalese wetland birds, comes under the category of endangered or threatened critically (Inskipp *et al.*, 2016).

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Nepal is a mountainous country. It is also rich in varieties of natural resources such as water resources, forest, different floras and faunas and minerals. Most of the wetlands are rich in food resources. 185 species of fishes, 102 species of phytoplankton, 109 species of zooplankton, 37 species of arthropods, 192 species molluscs, 53 species of amphibians, 80 species of reptiles, 36 species of mammals attract all kinds of birds in Nepal (DNPWC, 2018).

MATERIAL AND METHODS

Study Area

Taudaha Lake is situated at $27^{\circ} 38'N$ latitude and $85^{\circ} 17'E$ longitudes. It is about 1400m above the sea level and is situated on the southern edge of the Kathmandu Valley (Shah, 2000). Taudaha is situated in southwest from Kathmandu, about 6 km from Balkhu Ring Road, on the way to Dakshinkali. It not only holds cultural significance but also is also important for its rich diversity of flora and fauna.

Taudaha Lake is a small lake in the outskirts of Kathmandu, in Nepal (Figure 1). The name comes from a combination of Newari words ‘*Ta*’, meaning snake and ‘*Daha*’, which means lake. Taudaha Lake is partly surrounded by rice paddies with its characteristic zigzag shape. It occupies an area of eighty *ropancies* and fourteen *anas*. It is about 6.8 m in depth. Legends have that the lake was created by Manjushree as a home for the serpents who lost their home when the valley was drained. Thus, devotees celebrate *Nagpanchami* in the name of *Karkat Nag Raja* and *Nag Rani*, once a year. This place is a paradise for a bird watcher during the winter season when the migratory birds fly and settles here. It is known to harbor more than 40 varieties of wetland birds, fishes and other aquatic fauna (Shah, 2016).

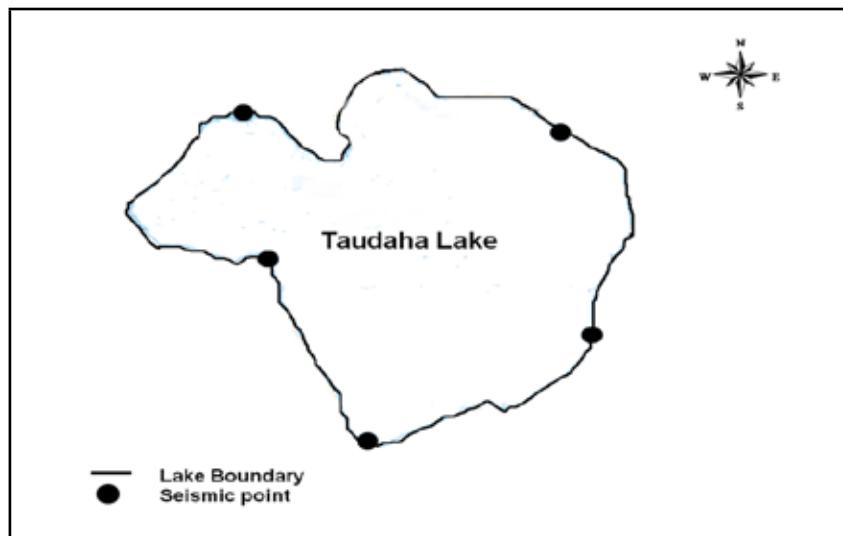


Figure 1: Locations of Study Sites, Taudaha Lake

Climate

The climatic condition of Taudaha Lake resemble with that of Kathmandu city. The average annual temperature and rainfall varies between $10^{\circ}C$ to $24^{\circ}C$ and 8 mm to 364 mm

respectively. According to the Department of Hydrology and Meteorology, highest relative humidity is in the month of November (85%) and the lowest in the month of April (53%).

Data Collection

The study was carried out between 15- 20 January 2019. Birds were counted by point-count method (Sarkar *et al.*, 2009). Five vantage points were taken around the lake and in each vantage point, 15 to 20 minutes time was spent for observing the birds (Figure 1). Peak activity in most birds lasts for 1 or 2 hours after sunrise or before sunset, therefore observations of birds were done during morning (7.00am-9.00am) and evening times (15.00pm-17.00pm) in sufficient sunlight at local time. Birds were enumerated by applying direct count method. Such a method has widely been used for enumerating wetland birds especially ducks (Khadka, 2013). RSPB 8x42 waterproof binocular and Canon powershot **5×40 HS** were used in the field. In addition, field guides like *Birds of the Indian Subcontinent* (2011) by Grimmett, Inskip and Inskip and *Birds of Nepal* (2016) by Grimmett, Inskip, Inskip and Baral were used in the study area to identify the birds.

Ethical and Legal Consideration

During the study period, no harm was done to birds as well as natural resources. The study was carried out after legal approval from Nepal Government.

RESULTS

A total of 16 species of birds belonging to 5 Orders and 5 Families were recorded in Taudaha Lake. The highest number of species belonged to the Order *Anseriformes* (10 species), followed by *Pelecaniformes* (3 species), *Gruiformes*, *Suliformes* and *Charadriiformes* (1 species each). The highest number of species in Family *Anatidae* (10 species) followed by *Ardeidae* (3 species), *Phalacrocoracidae*, *Rallidae* and *Laridae* (1 species each) were recorded. The analysis of data on residential status revealed that out of 16 species, 13 were winter visitors and 3 were residents.

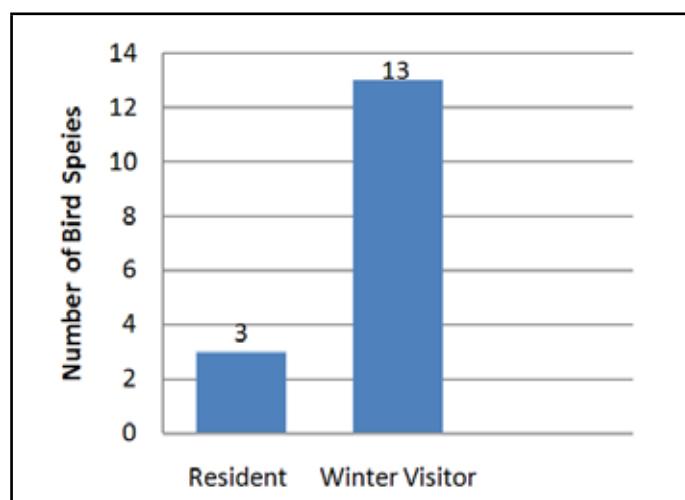


Figure 2: Residential Status of Bird Species in Study Area

Figure 3: Bar-headed Goose (*Anser indicus*)

Figure 4: Waterbirds in Taudaha Lake

Figure 5 : Little Egret (*Egretta garzetta*)

Figure 6: Mallard and Gadwall

DISCUSSION

During this study, 16 species of birds representing 5 Orders and 5 Families were recorded. However, Shah (2016) recorded 40 species of water birds belonging to 10 Orders and 18 Families from Taudaha Lake. This dissimilarity may be due to the size of coverage area. It is quite plausible that the earlier author observed birds not only in the Taudaha Lake but in the adjacent area also.

Common Pochard (*Aythya ferina*), Red-crested Pochard (*Netta rufina*), Grey Heron (*Ardea cinerea*) were not observed during this study even after careful and minute observation which were recorded previously by Shah(2016).The higher diversity of birds in January (winter season) was probably due to the addition of migratory waterbirds during this season.

In Taudaha Lake, most of the migratory birds were Duck species (Baral and Inskip, 2005; Bhushal, 2013). Many of the wetland birds found in Nepal are migratory in nature (Jha, 2016).

Once upon a time, Taudaha Lake used to be known as the nest of heaven for many wetland birds, stop over for many migratory birds. But the situation is alarmingly changing and birds are bypassing the area. Being a part of riverine ecosystem, fringing vegetation, a key source of organic materials and nutrients, depending on water runways is vital food resources for bird species. Instead of protecting that natural habitat, a solid concrete wall has been built, which affect the water runway of fringing vegetation and this is transforming the lake into a place of grasses and weeds. This does not suffice as the feeding habitat to bird species. Besides that, industrial development like restaurant, factories and residential areas are additional factors which causes disturbance to habitat of birds like Common Kingfisher (*Alcedo atthis*), White-breasted Kingfisher, Sandpiper (*Actitis hypoleucos*), Green Sandpiper (*Tringa ochropus*). Even Waterhen (*Amaurornis phoenicurus*) might become endangered, if remedial measures are not taken by the concerned authorities and civic population residing around the lake.

CONCLUSION

A total of 16 species of birds belonging to 5 Orders and 5 Families were recorded. Order *Anseriformes* was the dominant Order. *Anatidae* Family dominated the birds in Taudaha Lake. Comparatively, Common Teal (*Anas crecca*) was the most abundant species. This study recorded 3 resident types and 13 winter visitors. Large scale human settlement in the immediate surroundings of Taudaha Lake should be discouraged as these have negative effect over the migration of birds in the area.

ACKNOWLEDGEMENTS

The author would like to offer gratefulness to Prof. Dr. Ratna Thapa, Dr. Yogendra Shah and Tek Gharti Magar for their helpful and insightful suggestions. Author is also grateful to IDEA WILD for providing equipments for this research work.

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Table 1 : Systematic List of Birds in Taudaha Lake

S.No.	Common Name/Scientific Name	Seasonal status
SULIFORMES Order		
	Phalacrocoracidae Family	
1	Great Cormorant (<i>Phalacrocorax carbo</i>)	WV*
GRUIFORMES Order		
	Rallidae	
2	Common Coot (<i>Fulica atra</i>)	WV
ANSERIFORMES Order		
	Anatidae	
3	Northern Pintail (<i>Anas acuta</i>)	WV
4	Northern Shoveler (<i>Spatula clypeata</i>)	WV
5	Bar-headed Goose (<i>Anser indicus</i>)	WV
6	Common Teal (<i>Anas crecca</i>)	WV
7	Eurasian Wigeon (<i>Mareca Penelope</i>)	WV
8	Mallard (<i>Anas platyrhynchos</i>)	WV
9	Gadwall (<i>Mareca strepera</i>)	WV
10	Tufted Duck (<i>Aythya fuligula</i>)	WV
11	Ferruginous Duck (<i>Aythya nyroca</i>)	WV
12	Ruddy Shelduck (<i>Tadorna ferruginea</i>)	WV
PELECANIFORMES Order		
	Ardeidae	
13	Indian Pond-heron (<i>Ardeola grayii</i>)	R**
14	Black-crowned Night-heron (<i>Nycticorax nycticorax</i>)	R
15	Little Egret (<i>Egretta garzetta</i>)	R
CHARADRIIFORMES Order		
	Laridae	
16	Pallas's Gull (<i>Larus ichthyaetus</i>)	WV

WV*-Winter Visitor; R**-Resident

DIAGNOSTIC APPLICATION OF 99m Tc ECD SPECT ON CRANIOSYNOSTOSIS CHILDREN IN INDIA: A STUDY

*Dr. Mayadhar Barik**

ABSTRACT

Tc ethyl cysteinate dimer single-photon emission computed tomography (ECD SPECT) is currently used as a diagnostic modality. Our objective is to compare the data on craniosynostosis (CS) patients and comparing with radiological findings of X-ray skull, CT, and 99m Tc-ECD SPECT (before and after the surgery). A total of 450 (144) patients (300) without craniosynostosis (control group) and cases left out(6) including the study from January 1990 to 2020 was prospectively observed. All patients and parents had taken ethical consent and form duly filled in both Hindi and English. Out of 450 cases, there were 232 boys & 218 girls (age varying between 4 - 72 months). Observed detection rates (ODR) were compared with diagnostic test of 99m Tc-ECD SPECT with respect to X-ray, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), and the result was 80.0%, 57.1%, 83.0%, 52.2% respectively. This value is followed by the correct count (CC 73.68%). In addition, comparing with diagnostic test of CT with respect to X-ray showed sensitivity, specificity, PPV and NPV of 52.7%, 85.7%, 90.6%, and 40.9% respectively. 99m Tc-ECD SPECT revealed regional hypo-perfusion in the cerebral hemisphere in preoperative patients of craniosynostosis (CS) corresponding to the fused sutures. Technetium- 99m ECD SPECT showed a great promise for the evaluation of patients with craniosynostosis (CS) and we strongly recommend for the clinical correlation of craniosynostosis cases of both syndromic and non-syndromics. In future, corroboration with the better aetio-pathogenesis and the mechanism of regional cerebral blood flow (rCBF) may be performed.

Keywords: Craniosynostosis (CS), phenotypes, skull, Technetium- 99m ECD SPECT, X-ray.

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INTRODUCTION

Craniosynostosis is a type of craniofacial abnormality wherein the cranial sutures close early, while the baby's brain and skull are still growing. Craniosynostosis (CS) consists of premature fusion of one or more cranial sutures [1]. It may result from a primary defect of ossification known as primary craniosynostosis [2]. Another very common occurrence is during failure of brain growth on secondary craniosynostosis [3]. Complexes or compound craniosynostosis (CS) is premature fusion of multiple sutures [4]. Children with craniosynostosis (CS), which is usually complex, also affect body and causes deformities located in different fashion [5-6]. Syndrome and non-syndrome are two form of craniosynostosis (CS). Incidences of craniosynostosis (CS) varies globally with different causal factors [7-8].

MATERIAL AND METHODS

Ethical Clearance: The study was approved by the Institutional Ethics Committee of All India Institute of Medical Sciences, New Delhi, India. The patient's consent and information sheet (PIC&PICF) was both obtained for the study in both Hindi and English language.

Selection of Images: A total of 450 persons that included 144 patients, 300 without craniosynostosis (control group) and 6 cases left out including the study from January 1990 to 2020 was retrospectively observed. Out of 450 cases, there were 232 boys and 218 girls (aged 4 - 72 months). All patients had undergone X-ray skull, CT, and 99m Tc-ECD SPECT (before and after the surgery). The results were correlated with radiological and surgical findings. All the affected children underwent a detailed clinical evaluation including assessment of vision, endoscopy. All of the children had plain X-rays of the skull obtained in four views (antero-posterior, lateral, basal and Towne's). This was followed by a CT scan and 99mTc-ECD SPECT (before and after) upon the surgery of the head to evaluate the extent of sutural involvement, associated ventriculo-megaly, atrophy, sulcal spaces and parenchymal changes.

Inclusion Criteria: Patients with family members were included in our study.

Exclusion Criteria: We excluded those patients who had not undergone surgery or those who had no visual activity and no perception to light.

SPECT Studies and Processing: SPECT studies were performed in our department, between 15 and 30 min of intravenous administration of 99mTc-ECD (350 MBq-550 MBq) on an Elscint SP-4 orbit SPECT system with a truncated single head. SPECT images 360° were acquired with 6° intervals in the step and shoot mode, circular orbit. The raw data was normalized for uniformity; entry of rotation and gantry motion correction. Trans axial slices are generated with convoluted back projection reconstruction, using a ramp and hamming filter. A factor of 0.125 was applied for attenuation correction. Single pixel slices in the coronal, sagittal and oblique planes were obtained. All the slices were viewed on a colour monitor by three observers. An abnormal study included with asymmetry on two sides greater than 10%, defect size of more than one slice (1 pixel) in thickness and extent of the lesion in more than one plane. The consecutive clinically diagnosed patients of craniosynostosis were taken for the investigation.

STATISTICAL ANALYSIS

The demographic data as well as characteristics of the CS&NCS studies were expressed as mean with standard deviation, and percentages. Analysis of the data based on the radiological findings of craniosynostosis has been done using the statistical package Stata 13.1. Using this software, we have calculated odds ratio (OR), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), correct count (CC), parametric and nonparametric test to see the various significance level according to the research interest.

RESULTS

In Table 1, we provide the baseline characteristic with percentage (%) in syndromes, non-syndromes and common sutures involved in craniosynostosis children.

Table 1: Baseline Characteristics of Asian Indian Craniosynostosis Children

Sl.No.	Characteristics	Patient (n=144)	Percentage
(i)	Syndromes(n=22)		
	Apert	13	65
	Crouzon	6	40
	Saethre-Chotzen	2	8
	Lambdoid	1	5
(ii)	Non-syndromic(n=122)		
	Brachycephaly	45	55
	Scaphocephaly	37	50
	Trigonocephaly	20	47
	Plagiocephaly	11	23
	Oxycephaly	9	10
(iii)	Common sutures involved		
	Sagittal	27	56
	Coronal	25	54
	Metopic	22	52
	Asymptomatic	48	96

DISCUSSION

In our experience, primary craniosynostosis (PCS) cases located earlier had now turned into secondary craniosynostosis and nonsyndromic craniosynostosis (NCS) frequently accompanied with Asian Indian Scenario [9-10]. The frequencies of the various types of craniosynostosis (CS) are as follows: sagittal (60%), coronal (30%), metopic (15%), and lambdoid (5%) [11-12]. Raised intracranial pressure (ICP) is rare with fusion of a single suture [13]. It can occur in primary craniosynostosis (CS) when multiple sutures fused [14]. The major morbidity is due to the abnormal shape of the skull and intracranial pressure (ICP) [15] and occurs with a high frequency in multiple suture synostoses and rarely with single

suture synostosis [16]. In secondary craniosynostosis, typically no morbidity is noted, except that related to the underlying disorder. The lack of brain growth is often associated with neurodevelopment delay [17] Cosmetic defect (CD) is one of the cause in primary morbidity [18]. Although the craniosynostosis (CS) is equally distributed in both (boys and girls). Boy's frequency getting higher in our clinic. Neonatal period, screening and observation and gene therapy in craniosynostosis (CS) are also of significant importance [19]. At births, craniofacial abnormalities are located. In Infancy (0-18 months) secondary or primary craniosynostosis (CS) becomes evident as the child grows [20] basically the craniofacial abnormalities are non-syndromic craniosynostoses (NSCS) due to premature fusion of one or more craniofacial sutures. Functional impairment is also caused either by a pathological growth pattern or increased intracranial pressure (ICP). Indications for surgery are to increase intracranial volume (ICV) and to correct aesthetics [21-22].

Parental Age, Occupation and Nutrition: Paternal age at marriage, maternal age at marriage, sex partner and conception at due time are quite important part to avoid this type of circumstances. Occupation and nutritional support is more crucial part during pregnancy (iron, folic acid, vitamins are necessary) for both urban and metropolitan people (**Table 2**)[23-24].

Table 2: Comparison of Demographic Pprofile with Cases and Control Group

S.N.	Characteristics	Cases(n=144)	Control (300)	P-value
1.	Patient age(Months)	2.69 ± 4.28	1.94 ± 3.36	0.44
2.	Male sex	232 (450)	275 ± 262	0.28
3.	Mean birth weight(g)	2650 ± 492	2852 ± 520	0.05
4.	Gestational age(week)	36.2 ± 2.6	38.2 ± 2.7	0.56
5.	Normal delivery	25 (75)	106 (84)	0.34
6.	Paternal age at marriage (year)	30.15 ± 3.5	26.4 ± 1.8	0.35
7.	Maternal age at marriage (year)	26 ± 3.5	25 ± 4.4	0.25

Data in bracket indicated as % nearest to round figure, P-value significant at < .0001.

CONCLUSION

The high quality SPECT images is found as a result of the optimal physical and biologic characteristics of the tracer. Technetium-99m ECDSPECT shows promise for the evaluation of patients with Craniosynostosis (CS). Based upon our results and observation, we strongly recommend that it should be counted as the Gold standard for the clinical co-relations and evaluation of all craniosynostosis (CS) patients management or protocol development.

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ENDOPHYTIC ACTINOMYCETES AS A MICROMANAGER IN CHICKPEA: CASE STUDY OF EFFECTIVENESS AGAINST *Sclerotium rolfsii*

*Satyendra Pratap Singh**
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*Rajeeva Gaur****

ABSTRACT

Endophytic actinomycetes are the most important constituent of host ecosystem, known for the rich source of novel metabolites and several biological activities and has been considered as an emerging tool for crop management in the modern agricultural practices. In this study, the supplementation of potent endophytic actinomycetes viz. S. diastaticus SP2, S. fradiae SP4, S. olivochromogenes SP5, S. collinus SP8, S. ossamyceticus SP10, and S. griseus SP12 were examined for disease and health management in chickpea against the pathogenicity of S. rolfsii at field condition. Seed primed with the S. griseus SP12 demonstrated early emergence (90.5%) and enhanced seedling vigor index (4.6 fold) compared to the pathogen infested control. The treatment of S. griseus SP12 offered 4.24-fold reduction in plant mortality against the pathogen infested plants (85.8%). Furthermore, the supplementation of endophytic actinomycetes was able to significantly enhance the plant growth promoting attributes of treated plants under pathogenic stress condition. Additionally, scanning electron micrographs of collar region further confirmed the endophytic nature and antagonistic potential of S. griseus SP12 against S. rolfsii along with undamaged epidermis, pith and metaxylem tissues. Moreover, the richness of rhizospheric microbial communities was also assessed through the carbon utilization pattern (BIOLOG). The maximum fold change in rhizospheric microbial load

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(2.44-fold) was found in plants treated with *S. griseus* SP12 under pathogenic stress condition. Moreover, a significant variation in the microbial dynamics was revealed in the rhizospheric region of *S. griseus* SP12 treated plants in contrast with infested control. The results determine that application of endophytic actinomycetes confers resistance against *S. rolfsii*, ameliorate the plant physiological attributes, and enhance the diversity of rhizospheric microbiota, thereby contributing in host fitness and disease management at field condition.

Keywords: Endophytic actinomycetes, *Cicer arietinum*, germination, infestation, microbial dynamics, pathogenicity, *S. rolfsii*, seedling vigor index.

INTRODUCTION

In sustainable agricultural practices, developing countries are facing a lot of challenges to fulfil the demand of rapidly growing population. To meet the global food requirement, agriculture productivity must grow substantially, whereas the productivity of agricultural land is continuously decreasing (Foley *et al.*, 2011). Simultaneously, the emergence of phytopathogens causes serious threat to the productivity and quality of crops. At the same time, the pesticides and chemical fertilizers are extensively being used to increase the agricultural productivity, which also causes substantive effect on the quality and yielding attributes of crops.

Therefore, there is unmet need of cost effective and eco-friendly practices in agriculture systems that not only boost the productivity of crops but also enhance the soil fertility by the replenishment of beneficial microbial population in soil. In that way, to fulfil the escalating demand of the crop productivity, an eco-friendly approach is needed for the development of potent endophytic actinomycetes as an antagonist-based formulation related to the disease management as well as plant growth promoting activities.

Among endophytes, actinomycetes are widely spread in the nature, and represent the major taxonomic group that effectively colonize in most of the plants found in the different ecosystems (Singh and Dubey, 2018). They are widely known to synthesize a range of bioactive compounds and play a decisive role in antagonism and plant growth promotion (Qin *et al.*, 2011). Endophytic actinomycetes are efficiently able to enhance the crop fitness along with reducing the pathogenicity of several phytopathogens by the secretion of antimicrobial substances, alteration in plant physiology and induction of the defence pathway in plants for the resistance against phytopathogens (Govindasamy *et al.*, 2014; Kurth *et al.*, 2014). *Streptomyces* is the most common genus which are found as endophytes in several plants (Coombs and Franco, 2003) and previous studies highlight that most of the biologically active metabolites are synthesized by this group. Recent studies also reported that endophytic actinomycetes are good source of chitinases and thus easily ruptures the conidiophores and mycelium of several fungal phytopathogens (Singh and Gaur, 2016; Taechowisan *et al.*, 2003).

Endophytic actinobacteria also govern the secretion of an array of defence related enzymes and genes such as Peroxidase (PO), Lipid Peroxidase (LPX) and Phenylalanine Ammonia Lyase (PAL), phenolic compounds and specific flavonoids along with induction of pathogenesis

related PR- proteins to confers the host disease resistance against several biotic and abiotic stresses (Conn *et al.*, 2008; Singh and Gaur, 2017). Moreover, endophytic actinomycetes can enhance the early emergence of seedlings by the production of several hydrolytic compounds (Franco *et al.*, 2007; Abdul Baki and Anderson, 1973). Additionally, they ameliorate the plant growth promoting traits by the acceleration of plant growth regulating hormones i.e. Indole-3-Acetic acid (IAA), Gibberellic acid and Auxin for apical and secondary growth (Taechowisan *et al.*, 2005), production of siderophores, solubilization of phosphates, decomposition of organic materials, such as cellulose, lignocellulose, starch and chitin in soil (Goudjal *et al.*, 2016; Passari *et al.*, 2015).

Chickpea (*Cicer arietinum*) is one of the staple leguminous crop and mostly grown at arid and semi-arid regions of the world. A number of plant invaders including fungi, bacteria, viruses and nematodes often causes pathogenicity at different stages of this crop. Out of them, *Sclerotium rolfsii* is considered as one of the most devastating pathogen and responsible for the collar rot disease in chickpea (Maurya *et al.*, 2009). The hyphae of *S. rolfsii* closely adhere to the epidermis of the susceptible host and penetrate in the endodermis region (Nene *et al.*, 2012). *S. rolfsii* initiate the infection by the invasion of hyphae in the different tissues of plant. Later the vascular bundle of the plant is completely damaged and blocked by the profuse growth of *S. rolfsii*. Finally the plant infected with *S. rolfsii* is turned into yellow with wilting symptoms and the plant becomes dry (Taraifdar *et al.*, 2018). The pathogen is reported to cause pathogenicity in the first month after sowing of plant and severely affected the plant productivity (Nene *et al.*, 2012).

The application of the endophytic actinomycetes inoculum against *S. rolfsii* provides a reliable, eco-friendly, cost effective and non-disruptive approach that facilitates the management of plant pathogens. Additionally this technology may also be effective in different cropping systems, including horticulture, floriculture and other staple crops. Therefore, the present study aims to investigate the endophytic actinomycetes inoculum at field condition, and also attempts to examine the richness of rhizospheric microflora of host plants.

MATERIALS AND METHODS

Microbial Inoculums and Seed Priming with Endophytic Actinomycetes:

All the selected potent endophytic actinomycetes namely *S. diastaticus* SP2, *S. fradiae* SP4, *S. olivochromogenes* SP5, *S. collinus* SP8, *S. ossamyceticus* SP10, and *S. griseus* SP12 were distinctively inoculated in GYM (Glucose yeast malt) broth and incubated at $32\pm 2^{\circ}\text{C}$ for one week. After incubation, the isolates containing broth culture was centrifuged at 1000 rpm for 10 min and further re-suspended in saline (0.85% NaCl) to maintain the concentration of microbial cell up to 10^8CFU ml^{-1} (Singh *et al.*, 2015). These endophytic actinomycetes were selected on the basis of their antagonistic potential and plant growth promoting abilities (Singh and Gaur, 2016). The pathogen *Sclerotium rolfsii* were successfully isolated from the infected plant of chickpea and inoculated in PDA (Potato Dextrose Agar, *Hi-media*, Mumbai, India). The pathogen was multiplied by using sterile rice bran (20 kg rice bran; 50% moisture) and incubated at $28\pm 2^{\circ}\text{C}$ for 2 weeks (Ray *et al.*, 2017). After incubation, the rice bran was mixed severally for homogeneous distribution of fungal mycelia and stored aseptically for the

surface application of *S. rolfsii* at field condition. The cell suspensions of selected endophytic actinomycetes were individually primed on the surface sterilized chickpea seeds (cv. Radhey) with the help of 10% (w/v) CMC (carboxyl methyl cellulose, *Hi-media*, Singh and Gaur, 2017).

Field Experimental Set-up

To assess the efficacy of potent endophytic actinomycetes against *S. rolfsii*, the treated chickpea seeds (100 seeds per micro-plots) were sowed in the 40 micro-plots ($9 \times 9 \text{ m}^2$ per micro-plots) at field condition. The experimental setup contained following treatments: (1) Control (without any treatment); (2) Control+ Infested (contains only *S. rolfsii*); (3) *S. diastaticus* SP2 +P (SP2 with *S. rolfsii*); (4) *S. fradiae* SP4+ P (SP4 with *S. rolfsii*); (5) *S. olivochromogenes* SP5 +P (SP5 with *S. rolfsii*); (6) *S. collinus* SP8+P (SP8 with *S. rolfsii*); (7) *S. ossamyceticus* SP10+P (SP10 with *S. rolfsii*) and (8) *S. griseus* SP12 +P (SP12 with *S. rolfsii*). The mycelium of pathogen (*S. rolfsii*) containing rice bran was sprinkled over the surface of micro-plots (500gm per plot; as per the treatment) for pathogenic infection. The soil of micro-plots had 7.5 pH, ~55% water holding capacity, 0.39 dSm^{-1} EC along with 58:560:115mg N:P:K kg⁻¹. All the field experiment was designed by using randomized block designing (RBD) with five replicates of each treatment.

Seed Germination:

To examine the effect of the endophytic actinomycetes supplementation on seed emergence, the seed germination rate and vigor index was examined as per the previous described procedure (Abdul-Baki and Anderson, 1973). All the observations were recorded in randomly selected three plants per micro-plots with five technical replicates.

Disease Severity:

The pathogenicity of *S. rolfsii* on endophytic actinomycetes treated chickpea plants were recorded after the 2 week after pathogen inoculation. The mortality rate (in %) of endophytic actinomycetes treated plants were recorded by using the following formula (Singh *et al.*, 2015):

Analysis of Plant Growth Promoting Traits:

Different biocontrol agents treated plants (randomly selected) were uprooted from each micro-plots and several plant physiological attributes i.e. shoot length, root length, fresh weight, dry weight, number of flowering, number of branches, and number of nodulation were recorded to assess the plant growth promoting abilities of endophytic actinomycetes under pathogenic stress condition (Singh and Gaur, 2016).

Scanning Electron Microscopy (SEM):

Scanning electron microscopy was performed to validate the biocontrol efficacy of most effective endophytic actinomycetes treatment against *S. rolfsii* at field condition. Transverse section of the plant root (collar region) of *S. griseus* (most effective tested strain), control and control + Infested treatments were observed at fruiting stage of plant and analysis was made for the root tissue disintegration after pathogenicity.

The TS of collar regions of plant roots were fixed with 2.5% gluteraldehyde and containing

Sodium Cacodylate buffer (0.1M; *Hi-media*) and stained with 2% (w/v) OsO₄ (Osmium tetroxide) for 4 hrs. The sections were further dehydrated through the gradient of acetone (30-100%) followed by critical point drying (K850-Critical Point Dryer, Quorum Technologies). After dehydration, the TS sections were finally coated with gold-palladium by using Pelco 3 sputter (SC 7620, *Quorum Technology Ltd.*, UK). The sections of collar region (from three individual samples) were observed through Scanning Electron Microscope (Quanta 450FEG, FEI, The Netherlands).

Quantitative Estimation of Chitinase Activity of Soil:

Chitinase activity of the rhizospheric soil of different treatments was quantified as per the protocol of Ueno and Miyashita (2000) with modifications. Briefly, the rhizospheric soil (5gm) were homogenized in 10 ml of (w/v) 1% colloidal chitin suspension and incubated at 30°C, 120 rpm for 7 days. Soil containing suspension (1ml) considered as crude enzyme was sampled every day after incubation. The supernatant of soil suspension was mixed with 0.5% colloidal chitin containing phosphate buffer (0.1M; pH 7.0) and incubated at 32°C for 1 hr. The reaction was terminated through the addition of 3, 5-dinitrosalicylic acid (DNS) reagent (2ml) which was followed by the incubation at 100°C for 5 min. The spectrophotometric absorbance was recorded at 540 nm. The chitinase activity was expressed as the nanomoles of N-acetylglucosamine (GlcNAc) released by soil per minute.

Assessment of Rhizospheric Microbial Diversity

Biolog Eco and MT plates (Biolog, Inc., Hayward, CA, USA) based carbon source utilization profiling were used to examine the impact of endophytic actinomycetes treatments on rhizospheric microbial dynamics under pathogenic stress condition (Nautiyal, 2010 a,b). Rhizospheric soils (10.0g) were poured into 99 ml saline (0.85% NaCl) and incubated at room temperature, 120 rpm for 60min. After incubation, 150µl aliquot of 10⁻³ dilution was inoculated into the wells of Biolog Eco and MT plates and incubated at 30±2°C for one week. The rate of utilization was defined by the reduction of tetrazolium dye (redox indicator dye), that turns colorless to purple after the utilization of carbon source. The data of utilization pattern were recorded for one week at 590 nm. The pattern of utilization was expressed in terms of average well color development (AWCD) as describe earlier (Garland, 1996). The diversity richness and evenness indices were calculated as per the method of Nautiyal, (2009). PCA (Principle Component Analysis) was carried out by using the utilization pattern of Biolog Eco plate (Garland and Mills, 1991). Biolog MT plate was used to determine the utilization of amino acids, carbohydrate and miscellaneous, polymers, and carboxylic group by rhizospheric microbial communities. Moreover, the microbial load at rhizospheric region of endophytic actinomycetes treated plants was also examined to assess the impact of bio-inoculums on rhizospheric microbial colonization. The colonization of rhizospheric microbial communities was expressed in terms of log₁₀ colony forming unit per gram of rhizospheric soil (CFU g⁻¹).

Statistical Analysis

The level of significance and analysis of variance (ANOVA) were used to assess the significant level between control, Control+ Infested and endophytic actinomycetes treated plants under pathogenic stress condition by using SPSS package (SPSS ver. 16.0, SPSS Inc.,

Chicago, USA). Moreover, significant level between the treatments and controls were analyzed by Tukey's multiple range test at $p < 0.05$. The Hierarchical clustering and Principal component analysis (PCA) was executed by using PAST3 software.

RESULTS:

Impact of Endophytic Bio-agents on Plant Vigour Index and Germination Rate:

The priming of potent endophytic actinomycetes on surface sterilized chickpea seeds were remarkably ameliorates ($P < 0.05$) the seed vigor index and germination rate (Figure 1). The maximum seed germination rate (90.5%) and seedling vigor index (3592.68) was recorded in the treatment of *S. griseus* SP12, followed by *S. ossamyceticus* SP10 and *S. olivochromogenes* SP5 which showed 83.5% and 72.5% germination, with 3183.96 and 2547 vigour Index respectively. Moreover, control and control+Infested treatment recorded 63% and 29.75% germination rate along with 1763.56 and 769.51 vigor index respectively (Figure 1). The other treatments of endophytic actinomycetes also showed noticeable activity in terms of seed germination and vigor index.

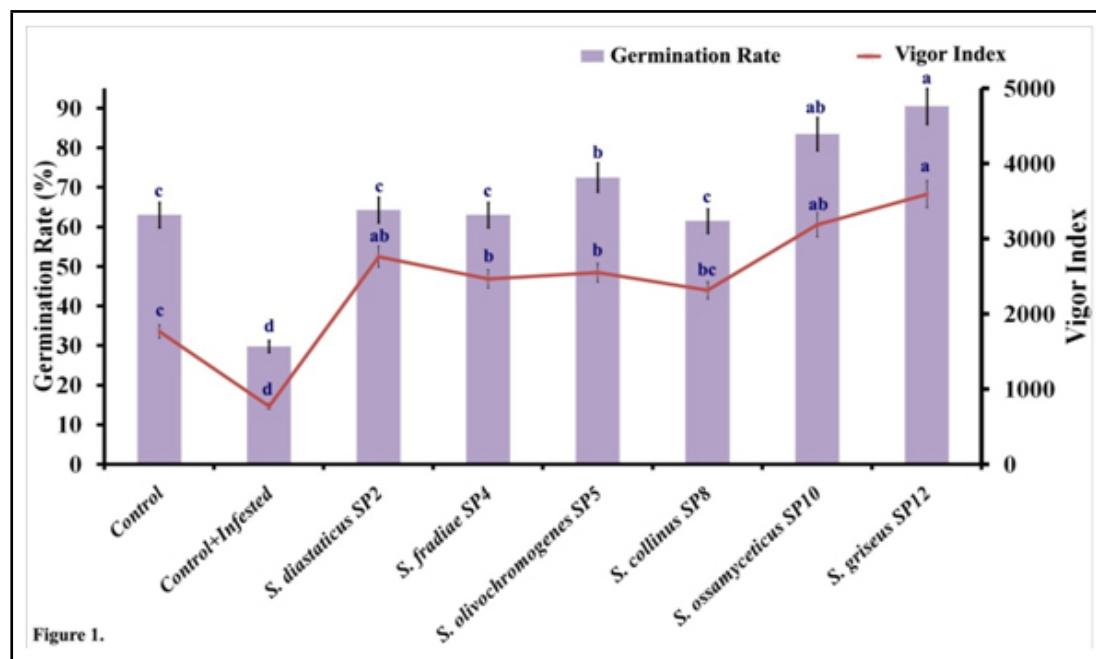


Figure 1.

Figure 1. Effect of endophytic actinomycetes on seed germination, and seedling vigour index of chickpea under pathogenic stress condition at field condition. Error bar represent the standard errors of six replicates. Means followed by the same letter(s) within the column are not significantly different according to Tukey's multiple comparison test ($P \leq 0.05$).

Effect of Endophytic Bio-agents on the Mortality of Chickpea plants:

Reduced disease severity was witnessed after pathogen inoculation as the plants treated with endophytic bio-agents demonstrated their efficiency against *S. rolfsii* infection at field condition (Figure 2). After 3-4 weeks of pathogenic infection, all the treatments showed

significant reduction in plant mortality rate as compared to pathogen infected (85.5%; control+infested) plant (Figure 2). The highest reduction in plant mortality was recorded in *S. griseus* SP12+P (4.24- fold), *S. olivochromogenes* SP5+P (3.25- fold) and *S. diastaticus* SP2 +P (3-fold) treatments as compare to pathogenic control plants. Seeds treated with *S. ossamyceticus* SP10, *S. collinus* SP8 and *S. fradiae* SP4 were also confirmed 2.94, 2.28 and 2.24- fold disease reduction under pathogenic stress condition respectively (Figure 2).

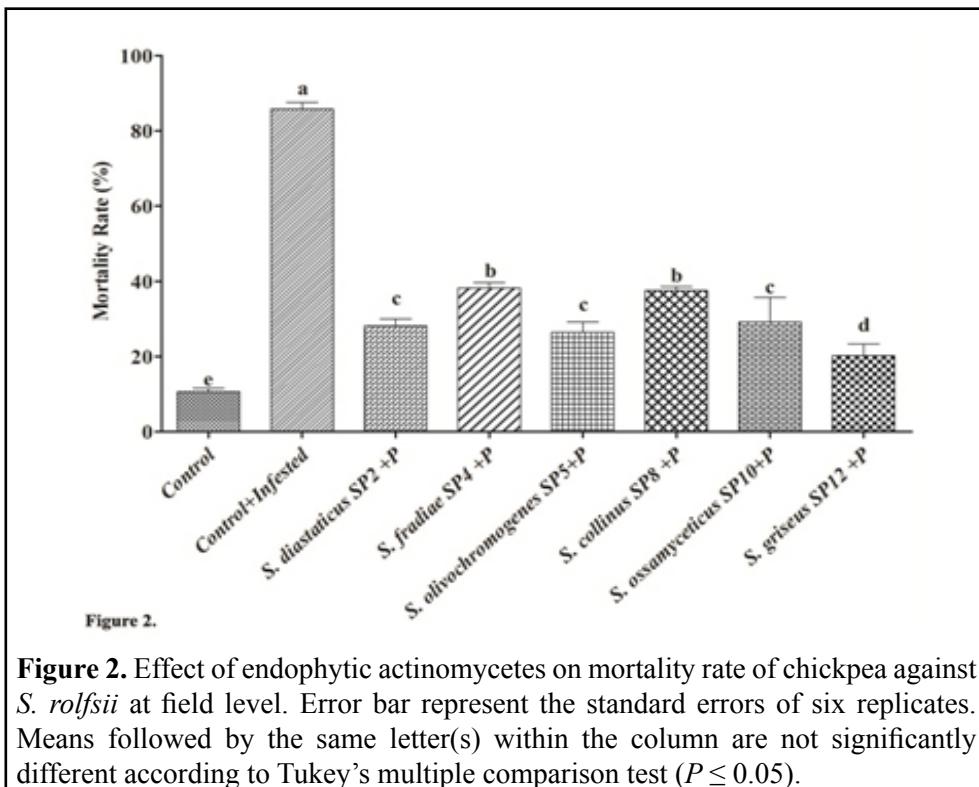


Figure 2.

Figure 2. Effect of endophytic actinomycetes on mortality rate of chickpea against *S. rolfsii* at field level. Error bar represent the standard errors of six replicates. Means followed by the same letter(s) within the column are not significantly different according to Tukey's multiple comparison test ($P \leq 0.05$).

Impact of Endophytic Bio-agents on the Physiological Performance of Chickpea plants

All the endophytic actinomycetes were also assessed for their plant growth promoting abilities under pathogenic stress condition at field level. The plants treated with potent bioagents exhibited significant ($P < 0.05$) increment in plant growth promoting attributes (Table 1). Although, the fold change of growth promoting traits in respect of only pathogen inoculated plants varied with treatments of different bioagents. The plant growth promoting attributes in terms of root length (3.6-fold), shoot length (2.8-fold), fresh weight (2.5-fold), dry weight (2.6 -fold), no. of flowering (3-fold), branches (3.1-fold) and nodulation (3.7-fold) was the result after maximum treatment of *S. griseus* SP12+P as compared to the pathogenic control (Table 1). This was followed by *S. olivochromogenes* SP5+P which showed 2.76, 2.14, 2.0, 2.5, 2.23 and 3.04 -fold increment in root length, shoot length, fresh weight, number of flowering, branches and nodulation respectively under pathogenic stress condition (Table 1). The maximum reduction in plant growth parameters was observed in the treatment of control

+ infested (only pathogen inoculated plant).

Impact of Most Potent Endophyte *S. griseus* SP12 Priming at Collar Region

The nature of resistance offered by the *S. griseus* SP12 against *S. rolfsii* was investigated through the scanning electron microscopy. The comparative analysis of TS sections from the collar region of *S. griseus* SP12 + P treated plant with non-pathogenic (control) and pathogenic (control+ infested) plants exhibited pathogenic devastation only in pathogenic control with immature appressorium, whereas, the infection of pathogen did not localize in control or *S. griseus* SP12 + P treated plants with pathogenic infection. The control treatment did not show any pathogenic infections (necrotic regions or mycelial growth) at collar region (Figure 3A, B, C, D). However, plant treated with only pathogen (control+ infested) exhibited advanced stage of infection and mycelium of *S. rolfsii* was localized at epidermis, pith and metaxylem at collar region (Figure 3E, F, G, H). The treatment of *S. griseus* SP12 with *S. rolfsii* (*S. griseus* SP12 + P) were depicted the adherence of *S. griseus* spores on completely destructed, ruptured, shriveled, disaggregated as well as squashed mycelium of *S. rolfsii* (Figure 3L). Apart from that, the spores of *S. griseus* were localized at epidermis and pith area of collar region (Figure 3J, K) which was found in normal condition as compare to infested control (Figure 3I, J, K). The plants treated with only *S. griseus* did not show any pathogenic infection and the adherence of *S. griseus* spores were localized at entire collar region (Figure 3M, N, O, P).

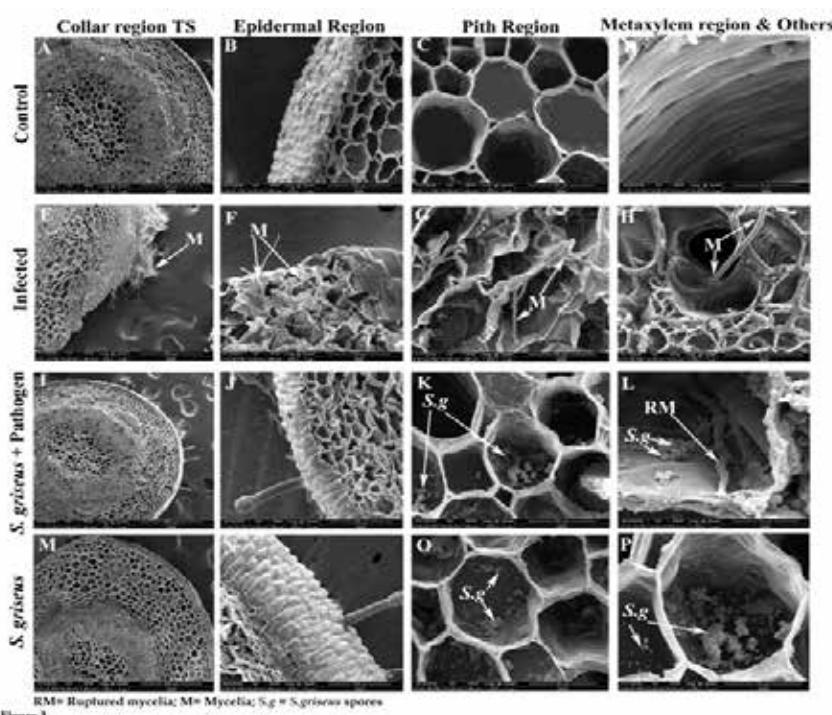


Figure 3.

Figure 3. Scanning electron micrographs of collar region of chickpea in (A-D) control, (E-H) control inoculated with pathogen, (I-L) *S. griseus* inoculated with *S. rolfsii* and (M-P) only *S. griseus* inoculated chickpea plant.

Chitinolytic activity of Rhizospheric Soil of Chickpea plants treated with Endophytic Bioagents

The chitinolytic activity of endophytic actinomycetes treated rhizospheric soil of chickpea plant was positively correlated with the antagonistic potential of rhizospheric microbial load of treated plants against fungal phytopathogens. The rhizospheric soil of endophytic actinomycetes treated plants showed steady and substantial chitinolytic activity during the incubation period (1-7 days). The treatment of *S. griseus* SP12+P recorded highest chitinase (ranging from 0.449 U mg^{-1} to 1.092 U mg^{-1}) activity, which was followed by treatment done by *S. olivochromogenes* SP5+P (0.353 U mg^{-1} to 0.74 U mg^{-1}) and *S. diastaticus* SP2+P (0.387 U mg^{-1} to 0.64 U mg^{-1}) (Table 2). Moreover, maximum chitinase production (1.092 U mg^{-1}) was observed in *S. griseus* SP12 +P at 7th day of incubation (Table 2) whereas, least was recorded in only pathogen inoculated control (Control+Infested) plant.

Impact of Endophytic Bioagents on Rhizospheric Microbial Dynamics

The population density of rhizospheric soil of endophytic bioagents treated plants ranged between 2.11 to $4.974 \log \text{CFU g}^{-1}$ (Table 1). The maximum colony count was revealed in *S. griseus* SP12 +P treatment ($4.974 \log \text{CFU g}^{-1}$) followed by *S. olivochromogenes* SP5 +P ($4.5 \log \text{CFU g}^{-1}$), *S. collinus* SP8 +P ($4.33 \log \text{CFU g}^{-1}$) and *S. diastaticus* SP2 +P ($4.03 \log \text{CFU g}^{-1}$) in contrast to the control treatment ($4.06 \log \text{CFU g}^{-1}$). However, least population density was observed in only pathogen treated rhizospheric soil ($2.11 \log \text{CFU g}^{-1}$) (Table 1).

The carbon utilization pattern based analysis of rhizospheric soil of endophytic bioagents treated plants was performed to examine the treatment mediated modulation of microbial diversity at rhizosphere. The observations based on the AWCD (average well color development) revealed that the treatment of *S. griseus* SP12 +P recorded highest metabolic activity whereas, the least activity was observed in the treatment of control + infested (Figure 4). The treatment of other endophytic actinomycetes also reflected moderate activity under pathogenic stress condition. The richness and evenness based diversity indices clearly demonstrated the significant variations among all the treatments (Table 3). The large set of observations related to the utilization of carbon substrates on Biolog ECO plate was further compiled through the principle component analysis (PCA). The microbial carbon substrate utilization pattern of *S. griseus* SP12 treated rhizospheric soil clearly showed the significant variation under pathogenic stress conditions and clustered separately (Figure 5). The most negative variation was revealed in the functional diversity of *S. roflsii* treated pathogenic control treated rhizospheric soil (Figure 5). Among all the treatments, *S. diastaticus* SP2 +P and *S. ossamyceticus* SP10 +P showed similar pattern in terms of carbon utilization as clustered together distinctly. The findings of PCA clearly revealed that the carbon substrate utilization profiling of rhizospheric microbial communities from *S. griseus* SP12 treatment under pathogenic stress condition (*S. griseus* SP12+P) is distinct from remaining treatments (Figure 5). The obtained data was further analyzed through the hierarchical clustering to achieve the relativity between the treatments and it was observed that the *S. griseus* SP12 showed similarity with *S. olivochromogenes* SP5 +P as they separately clustered in separate branch, while similar to the other findings the infected control depicted most negative relativity (Figure 6).

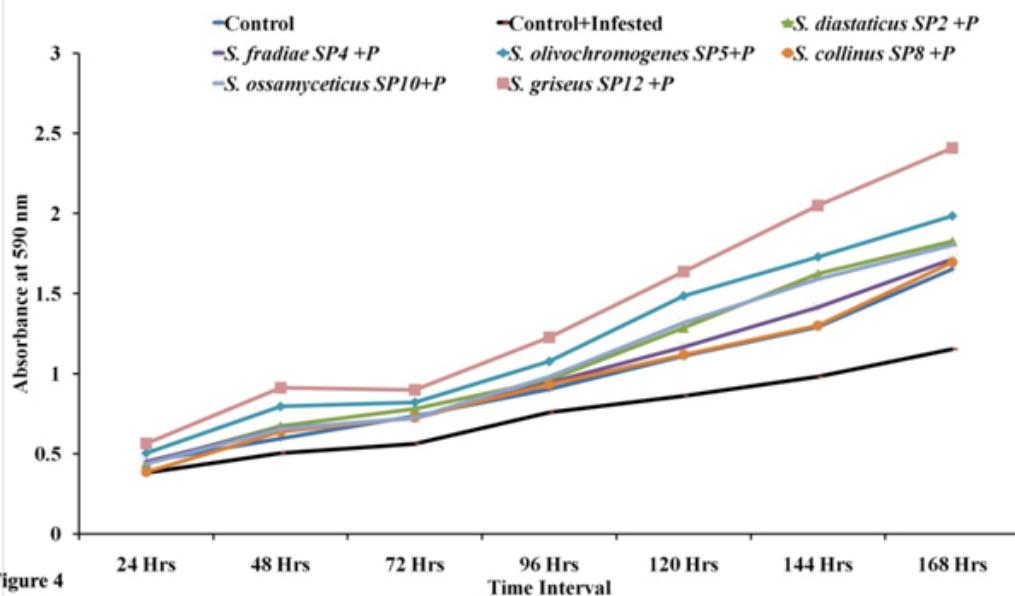


Figure 4

Figure 4. Average well color development (AWCD) based on substrate utilization pattern on Biolog Eco plates by endophytic actinomycetes treated chickpea rhizosphere microflora. The rate of utilization is indicated by the reduction of tetrazolium, a redox indicator dye, which changes from colorless to purple. Data were recorded for day 1–7 at 590 nm.

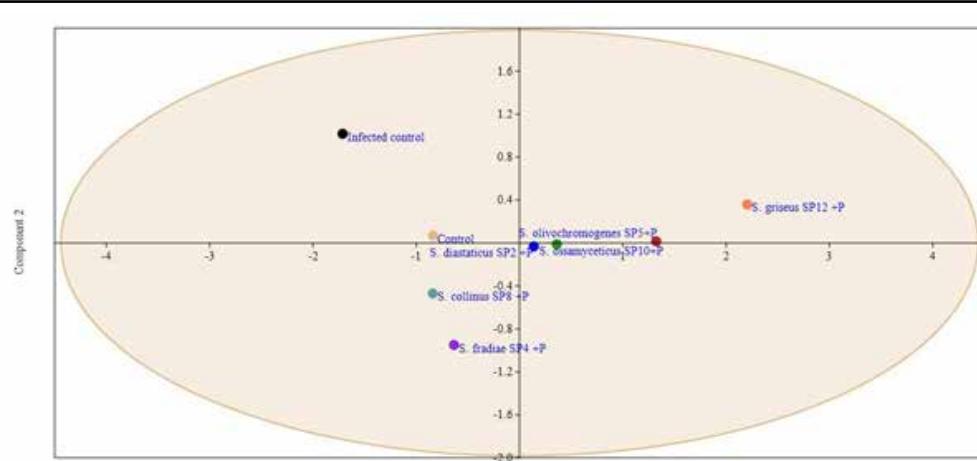


Figure 5

Figure 5. Principal component analysis (PCA) of carbon source utilization pattern on Biolog Eco plates (Biolog, Inc., Hayward, CA, USA). Control represents non-treated control. Control+Infested represent treatment with only pathogen (*S. rolfsii*). Other treatments represent the plants treated with different endophytic actinomycetes under the infection of *S. rolfsii* at field level.

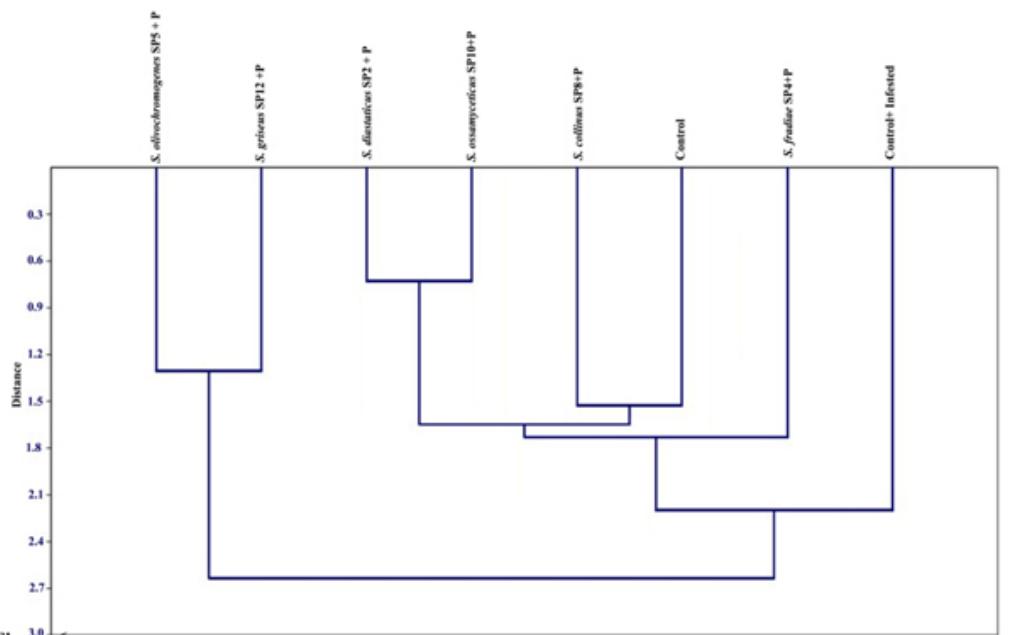


Figure 6

Figure 6. Hierarchical Clustering analysis based on the carbon source utilization pattern on Biolog Eco plates (Biolog, Inc., Hayward, CA, USA). Control represents non-treated control. Control+Infested represent treatment with only pathogen (*S. rolfsii*). Other treatments represent the plants treated with different endophytic actinomycetes under the infection of *S. rolfsii* at field level.

Biolog MT plate was used to assess the utilization of complex natural substrates (frequently found in nature) by the rhizospheric microbial dynamics of endophytic bio-agents treated plants. The maximum substrate utilization of amino acids, polymers and miscellaneous was achieved by *S. griseus* SP12 treatment under pathogenic stress condition (Figure 7). The treatment of other endophytic actinomycetes showed a range of significant variation in the carbon utilization pattern. Moreover, least carbon utilization pattern was recorded with the rhizospheric soil of infested control (Figure 7).

DISCUSSION

Endophytes offer great untapped potential which has made them crucial for agriculture as a tool in improving crop performance and because of the close association with host plants, endophytic actinomycetes are reported for their plant growth development and crop management in many studies (Singh and Gaur, 2017; Singh and Gaur, 2016; Toumatia *et al.*, 2016). Emerging evidences point towards effectiveness of actinomycetes based microbial inoculums and their consortium as a bio-formulation for disease management in several plants (Kanini *et al.*, 2013; Zhao *et al.*, 2010). However, the application of endophytic actinomycetes based formulation as a mechanistic control point for host fitness and immunity under pathogenic stress condition is still not much explored. Earlier findings of our laboratory has indicated that

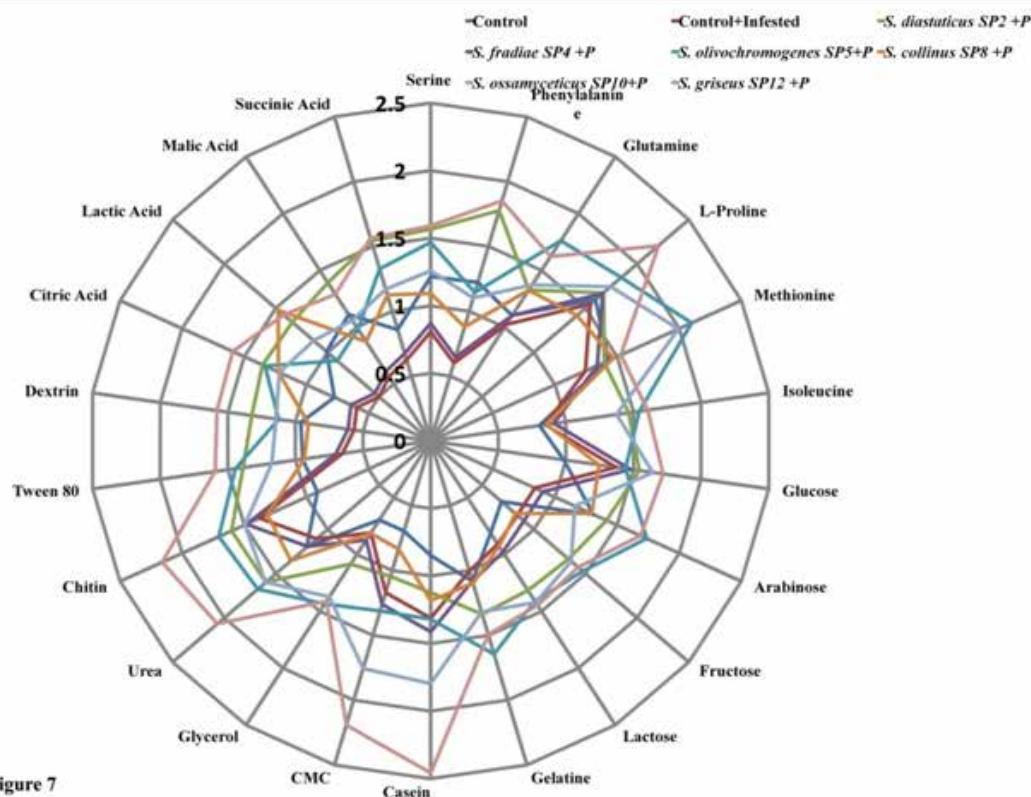


Figure 7. Carbon substrate utilization pattern of complex substrates in Biolog Mt plates. Control represents non-treated control. Control+Infested represent treatment with only pathogen (*S. rolfsii*). Other treatments represent the plants treated with different endophytic actinomycetes under the infection of *S. rolfsii* at field level.

the selected chitinolytic endophytic actinomycetes are able to ameliorate the nitro-oxidative burst and reduce the infection of *S. rolfsii* in chickpea at green house condition (Singh and Gaur, 2017; Singh and Gaur, 2016). Nevertheless, as per the current scenario of research, the researchers try to find out the most efficient endophytic actinomycetes that not only eliminate the deleterious effect of plant diseases, but also interact with host plants for their growth and health management. Therefore, the present investigation had been performed to further investigate the efficacy of selected endophytic actinomycetes at field condition and point out the best treatment for the management of *S. rolfsii* in chickpea.

The present findings revealed that under field condition, significantly enhanced germination rate and vigor index was recorded in *S. griseus* SP12 +P as compared to pathogenic control plants (Figure 1). The current findings are well corroborated with previous reports that several endophytes efficiently synthesize various hydrolytic compounds and consequently contributed in early seed emergence and better seedling output in terms of high seedling vigor index (Verma et al., 2019; Shaik and Thomas, 2019). Furthermore, several endophytes also accelerate the

production of Gibberellic acid to enhance the seed germination (Gupta and Chakrabarty, 2013).

To assess the effectiveness of endophytic actinomycetes against *S. rolfsii* at field level, the mortality rate of treated plants was also investigated. The present study confirmed the antagonistic approach of *S. griseus* SP12 against *S. rolfsii* in chickpea under field condition as it remarkably reduce the mortality rate of treated plant as compared to infested control (Figure 2). It was previously reported that actinomycetes are efficiently able to suppress the growth of different fungal phytopathogens (Patil *et al.*, 2010; Verma *et al.*, 2009). The mycoparasitic activities of endophytic actinomycetes might be attributed to the synthesis of several bioactive compounds, antibiotics, and extracellular enzymes i.e. chitinase and glucanase to confer the fitness of treated plants against fungal phytopathogen. Moreover, the current findings are in agreement with earlier reports in which the potent strains of endophytic actinomycetes were exploited as biocontrol agents for disease management in agricultural practices (Vurukonda *et al.*, 2018; Harekrishnan and Shanmugaiah, 2012; Cao *et al.*, 2005).

In agricultural practices, the applications of endophytic actinomycetes not only play a decisive role in disease management but also able to enhance the plant growth and yielding attributes. Similarly, the applications of endophytic bioagents positively affect the plant growth parameters such as root length, shoot length, fresh weight, dry weight, number of flowers, branches and nodulation under pathogenic stress condition (Table 1). Several reports demonstrated that close association between the endophytes and host plant effectively enhance the production of phyto-hormones i.e. Indole-3-acetic acid, Gibberellic acid and Auxin that governs the regulation of plant growth (Hardoim *et al.*, 2015; Golparyan *et al.*, 2018; Etminani and Harighi, 2018). Moreover, the production of siderophore (metal and iron-chelating compound) and solubilization of phosphate by endophytes also leads to the plant growth at cellular level (Kandel *et al.*, 2017; Souza *et al.*, 2015). Similarly, the earlier findings of *in-vitro* experiments confers the plant growth promoting attributes i.e. P-solubilization, Siderophore production, production of Indole acetic acid (IAA) and GA₃, production of selected endophytic actinomycetes (Singh and Gaur, 2016) which might be responsible for the cell elongation, mineralization and development of treated plant at field level.

The SEM micrographs of *S. rolfsii* SP12+P treatment clearly depicted the adherence the spore of *S. griseus* SP12 on the ruptured mycelium of *S. rolfsii* (Figure 3L) which was further confirmed the biocontrol efficacy of most efficient biocontrol agent namely *S. griseus* SP12. The disintegration of *S. rolfsii* mycelium might be because of the physical interaction of *S. griseus* SP12 with fungal body that governs the activation of several hydrolytic compounds, antibiotics and other antimicrobial substances. The micrographs from the collar region of *S. griseus* SP12 treated plants clearly exhibited intact epidermis, pith and metaxylem tissues (Figure 3I,J,K). Furthermore, the localization of *S. griseus* SP12 spores in the different area of collar region (Figure 3M, N, O, P) also confirmed the endophytic nature of most potent isolate. The similar trends were also revealed in previous findings where the treatment of endophytes confers host fitness towards the several fungal phytopathogens (Goudjal *et al.*, 2014; Derksen *et al.*, 2013; Patil *et al.*, 2010).

The recent studies have been focused on the chitinolytic microbes to insure the resistance of plants against several aggressive invaders because these microbes can efficiently utilize

the chitin containing fungal cell wall and directly responsible for the antagonism (Nagpure *et al.*, 2014). The findings of present investigation revealed that, the treatment of endophytic actinomycetes increased the chitinase activity in rhizospheric soil (Table 3). The highest chitinase activity in *S. griseus* SP12 treatment was attributed to the maximum number of chitinolytic microbial load at rhizosphere and possibly the production and secretion of chitinolytic enzymes by rhizospheric microflora might be also enhance the disease resistance of *S. griseus* SP12 treated plants.

Plant root associated microorganisms are key regulators of plant fitness. Because, the parasitic interaction of pathogens with plants considerably alter the plant secretomes and thus indirectly affect the richness of rhizospheric microbial communities (Schmidt *et al.*, 2019; Berendsen *et al.*, 2012; Nihorimbere *et al.*, 2011). As a result of these activities the invasion of plant pathogens negatively affected the diversity of rhizospheric inhabitants (Tan *et al.*, 2017; Latz *et al.*, 2015). Similarly, the diversity of rhizospheric microflora was reduced severely with the progression of pathogenic infection in *S. rolfsii* treated plants (Table 1) whereas, the plants treated with endophytic actinomycetes was revealed minimum pathogenicity and recorded significantly higher microbial load at rhizosphere.

Moreover, it was investigated in previous studies that plant deposited the maximum amount of exudates at rhizosphere for the management of microbial community structure, abundance, and activity of plant beneficial microflora (Steinauer *et al.*, 2016; Eisenhauer *et al.*, 2017). Whereas, the diverse group of rhizospheric microbiota address the soil fertility, plant growth, disease management and nutrient allocation (Gomez *et al.*, 2017). However, the pathogenic infection causes the devastating effect on the diversity of rhizospheric microbial communities (Sánchez *et al.*, 2017). This was well corroborated with current findings where the rhizospheric microbial diversity was gradually decreased with the intensity of pathogenic infection in only pathogen inoculated plants (Figure 4, 5 & 7). Moreover, the applications of endophytes are well known for disease management and plant growth regulation, but little is known about the effect of such applications on the plant rhizospheric community. Therefore, the current investigation was also intended to examine the effect of endophytic actinomycetes treatments on the richness of rhizospheric microbial communities during the infection of *S. rolfsii* at field level. The amelioration in the diversity of rhizospheric communities in endophytic actinomycetes treated plant reaffirms the contribution of endophytic bioagents for plant beneficiary activities (Figure 4,5 & 7). The current findings were further confirmed by previous reports that correlated the increased diversity of rhizospheric microbiota with disease management and host fitness (Qiao *et al.*, 2017; Ling *et al.*, 2014). The similar pattern was also reported in the case of *W. somnifera* where the rhizospheric microbial diversity was increased by the intervention of endophytes when the plants were infected with *A. alternata* (Mishra *et al.*, 2018).

In conclusion, the findings of current investigation very clearly demonstrate the mycolytic activity of potent endophytic actinomycetes against devastating pathogen *S. rolfsii* in chickpea at field level. Further the results also provide evidence that treatment of most efficient endophyte *S. griseus* SP12 not only confers the diminution of *S. rolfsii* pathogenicity but also perform a decisive role in host fitness through the early seed emergence, reduction in

disease severity and enhancement of plant physiological attributes under pathogenic stress condition. Furthermore, the beneficial effects of these endophytic actinomycetes significantly mitigate the richness of rhizospheric microbial diversity and enhance the abundance of chitinolytic microbiota at rhizosphere. The findings provide the further insights to explore the potent endophytic microbes for the development of an eco-friendly bio-formulation which not only is able to ameliorate the growth and development of plant but also diminishes the severity of fungal infection at field level. The present investigation highlights the pivotal role of potent endophytes that would make an immense addition towards integrated strategies for the management of several devastating diseases to meet out the global demand of agricultural production in near future.

Conflicts of interest

The authors have declared no potential conflicts of interest among them.

Acknowledgement

SP Singh is grateful to the Director, CSIR-NBRI, Lucknow, India, for providing required financial support and facilities during the experiments. Special thanks to Dr. Aradhana Mishra for her valuable support.

Availability of Supporting Data:

The data set supporting the result of this article is (are) included within the article.

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Table 1. Impact of Endophytic Bioagents Treatments on Plant Growth Promoting Attribute of Chickpea Plants

	Root Length (in cm.)	Shoot Length (in cm.)	Fresh Weight (in gm.)	Dry Weight (in gm.)	No. of Flowering Branches	No. of Branches	No. of Nodulation	CFU (\log_{10} CFU g $^{-1}$)
Control	7.06±0.37 ^c	13±0.29 ^d	14.636±0.57 ^d	4.348±0.24 ^c	14.2±0.75 ^d	12.2±1.03 ^d	13.8±1.16 ^c	4.06±0.33 ^b
Control+ Infested	3.62±0.2 ^e	8.3±0.7 ^e	9.29±0.62 ^e	2.906±0.19 ^d	7.2±1.03 ^e	7.8±0.8 ^e	5±0.7 ^e	2.114±0.16 ^c
S. diastaticus SP2+P	9.2±0.59 ^b	16.46±0.5 ^c	16.646±1.6 ^c	5.164±0.5 ^b	17.4±1.81 ^{b,c}	12.8±1.5 ^d	14.4±0.93 ^c	4.038±0.47 ^b
S. fradine SP4+P	5.94±0.56 ^d	13.92±0.7 ^d	14.818±1.1 ^d	4.124±0.37 ^c	15.4±1.39 ^c	14.8±1.1 ^c	13.2±1.39 ^d	2.848±0.23 ^c
S. olivochromogenes SP5+P	10±0.28 ^b	17.78±0.46 ^b	18.706±0.67 ^b	4.984±0.3 ^b	18.4±0.65 ^b	17.4±0.65 ^b	15.2±0.58 ^b	4.508±0.2 ^{ab}
S. collinus SP8 +P	9.78±0.32 ^b	17.54±0.65 ^b	16.008±1.27 ^c	5.653±0.26 ^b	14.6±1.05 ^d	12.4±1.04 ^d	12.8±0.58 ^d	4.332±0.26 ^b
S. ossomycescetus SP10+P	7.24±0.34 ^c	15.5±1.3 ^c	14.236± 0.65 ^d	0.18 ^c	18.6±0.65 ^b	15.6±0.65 ^c	14.2±1.35 ^c	2.472±0.14 ^c
S. grisens SP12 +P	13.06±0.69 ^a	23.44±0.24 ^a	23.402± 0.98 ^a	7.624±0.2 ^a	22.2±1.8 ^a	24.2±0.75 ^a	18.6±1.56 ^a	4.974±0.25 ^a

Values as mean of three replicates with \pm standard error (SE) are indicated. Means followed by the same letter(s) within the column are not significantly different according to Tukey's multiple comparison test ($P < 0.05$). The data presented are from representative experiments that were repeated at least twice with similar results.

Table 2. Chitinolytic Activity (U mL^{-1}) of the Rhizospheric Soil of Plants Treated with Endophytic Actinomycetes.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	0.234±0.04	0.309±0.02	0.342±0.015	0.303±0.01	0.310±0.01	0.31±0.01	0.327±0.04
Control+Infested	0.33±0.02	0.36±0.011	0.27±0.01	0.217±0.01	0.167±0.01	0.133±0.05	0.093±0.01
S. diastaticus SP2+P	0.387±0.02	0.43±0.012	0.463±0.1	0.52±0.01	0.57±0.02	0.6±0.01	0.64±0.02
S. fradiae SP4+P	0.387±0.015	0.43±0.01	0.48±0.1	0.51±0.02	0.56±0.01	0.53±0.02	0.44±0.01
S. olivochromogenes SP5+P	0.353±0.03	0.413±0.02	0.47±0.02	0.557±0.02	0.61±0.01	0.66±0.04	0.74±0.02
S. collinus SP8 +P	0.343±0.03	0.39±0.01	0.43±0.02	0.46±0.02	0.39±0.02	0.35±0.03	0.32±0.04
S. ossamyceticus SP10+P	0.327±0.02	0.353±0.01	0.37±0.01	0.433±0.01	0.557±0.01	0.537±0.03	0.59±0.02
S. griseus SP12 +P	0.499±0.02	0.57±0.01	0.653±0.02	0.751±0.04	0.807±0.03	0.873±0.01	1.092±0.033

Table 3. Impact of Endophytic Bioagents Treatments on Diversity and Evenness Indices of Rhizospheric Microflora of Chickpea Plants

	Control	Control+Infested	S. diastaticus +P	S. fradiae +P	S. olivochromogenes +P	S. collinus +P	S. ossamyceticus +P	S. griseus +P
Shan D	3.42±0.007	3.19±0.002	3.43±0.003	3.4±0.011	3.44±0.004	3.413±0.002	3.433±0.001	3.64±0.002
Shan Ev	0.987±0.002	0.977±0.006	0.989±0.001	0.982±0.003	0.992±0.001	0.985±0.007	0.99±0.003	0.998±0.004
Mac D	0.985±0.005	1.01±0.008	0.973±0.004	0.976±0.001	0.962±0.004	0.983±0.002	0.97±0.003	0.954±0.002
Mac Ev	0.993±0.008	0.984±0.004	0.994±0.006	0.988±0.001	0.996±0.007	0.991±0.004	0.994±0.002	0.998±0.004
Simpson	0.996±0.006	1.01±0.002	0.992±0.001	0.993±0.003	0.989±0.001	0.995±0.007	0.991±0.004	0.987±0.002

IMPACT OF PROMOTIONAL STRATEGIES OF COMMERCIAL BANKS ON CUSTOMER AWARENESS IN MID-WESTERN REGION OF NEPAL

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ABSTRACT

The role of banks as financial intermediaries and the delivery of banking services are facing new challenges than ever before. It is facing an ever increasing level of competition around the world as the dynamics of the business change. Technology, commoditization, deregulation and globalization have forever changed the face of banking. Banks have understood the need to capitalize on the new technologies to gain advantage in the competition by exploiting their customer base, brand value and costly infrastructure investments in order to increase profits, as there is a direct link between the customer satisfaction and the profitability. The customer ranked the bank on his/ her satisfaction level. This study carried out the answer over the impact of promotion on awareness level of bank customers about the bank services. A total of 404 respondents participated in the study and presented their views. It was revealed that there is significant difference between male and female in their satisfaction level for public and private banks.

Keywords: Banking services, Commercial bank, customers' awareness, promotional strategies.

INTRODUCTION

Nowadays, banking is playing important role in the world's economy. The banking functions are the routine actions of one's life. The emergence of commercial sector banks has changed the whole scenario of the banking actions in the recent years in Nepal. Banks nowadays plan to lay greater stress on consumer banking in the coming years, with a view to achieve market penetration and profitability. Technology has paved way for expanding the

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horizon of consumer banking and has smartened up the sedate business of banking. In the pre-liberalization days, banking was considered as imposition one would like to finish off as quickly as possible. Today the scenario is totally diverse. Banks compelled by ever growing competition have improvised on existing features, and created new facilities that are more customer-friendly. Growing Nepalese middle class today has a disposable surplus income and aspires for a better lifestyle.

The busy person needs money at any time, at anywhere and is eager to pay extra for such service. The breed of financial services brand viz. convenience banking, anywhere banking, tele-banking, branchless banking and on-line banking have appeared on the banking landscape. Most of the commercial banks have linked up their branches enabling a customer to operate his account from any, even from different parts of the country.

The banking system in Nepal, like many of the banking systems in the developing countries, emerged to facilitate trade transactions either domestically or cross-borders and as a tool used by the authority to foster the country's economic growth and development through the process of financial intermediation. The Nepalese financial sector is composed of banking sector and non-banking sector. Banking sector comprises Nepal Rastra Bank and commercial banks. There are 28 commercials banks in Nepal. Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners and society at large (Lanscaster & Massingham, 2011, p. 3).

Customer awareness, which refers to a buyer's knowledge of a particular product or company, allows the buyer to get the most from what he buys (Thomas, 2015). Today's customer is presumed to be aware of all kinds of financial services offered by the various financial institutions (Arora, 2005). In recent years, concern for the level of banking knowledge in society as a whole has grown considerably and is expected to grow even more important in the future (Fox, Suzanne, & L., 2005). To improve financial literacy and awareness of banking services, Nepal Rastra Bank had lunched strategic plan 2012-2016 focuses on financial awareness programs for women, victims of conflict, ethnic minorities, and deprived and marginalized section of population.

Promotion is the straightway an institute attempts to reach its customers. This function is carried out through elements of the promotion mix consist of advertising, sales promotion, personal selling, public relations and the directmarketing (Czinkota & Ronkainen, 2004).

Arora (2005) investigated that more than 50% of private bank customers were aware of all banking services and awareness level of foreign bank customers was very impressive; but customers of public and private sectors were not aware about some latest developments in corporate banking services such as options, swaps, and derivatives. Extent of customer awareness regarding banking services in public, private and foreign banks. Ramaswamy *et al.* examined found that management students attached a sound level of importance to financial literacy to their subject of study, they did not find the significant difference in the financial literacy level between male and female respondents while male and female's ability to read, analyze, manage and gender, language, race and income level did not have an impact on the

level of financial awareness (Ramaswamy, Thapermall, Dowlut, & M., 2013).

Ehigie (2006) examined how customer expectations, perceived service quality and satisfaction predict loyalty among bank customers in Nigeria. Bank management should pay attention to bank staff skill possession, knowledge, attention to customers and their needs, offering of fast and efficient services and general attitude to customerservices. Other issues for gaining customer loyalty in the Nigerian banking system include confidentiality in transactions, trustworthiness of bank, introduction of weekend banking, extension of banking hours, and provision of insurance for customers.

Ndubisi (2007) examined the impact of relationship marketing strategy on customer loyalty. Analysis assessed the impact on customer loyalty of four key constructs of relationship marketing (trust, commitment, communication and conflict handling). The four variables have a significant effect and predict a good proportion of the variance in customer loyalty. Moreover, they are significantly related to one another.

It is found that 63% of the respondents are partially aware about the internet banking services and 16% of them are totally unaware whereas gender annual income, occupation and marital status have no relevance on the awareness of internet banking services (Mahesh & Varsha, 2014).

The role of promotion has been redefined into handling long-term relationship with sensibly selected customers, including structure of learning relationship where the seller keeps a discussion with an individual customer (Dawes & Brown, 2000). Due to this fact, the employees are one of the most vital capitals of a bank. In banking services, people are mainly worried about security of their funds and default risks. Cox (2007) contends that banking service providers are not supposed highly trusted, so that they might have struggle in selling risk-based products.

Shende and Khursange conducted a study to identify the awareness of internet banking service among the customers of different banks and the preferences of the customers toward use of the e-banking. In the total users of the banking services the percentage of use of e-banking is 65% of total customers. More banks are collaborating with some software company to run the e-banking service. The services that are mostly used by maximum customers are transactions, online trading, bill payment, shopping etc. The satisfaction level of the customer is also highest in use of e-banking services. But they found that there is a major group of older age people who are hesitant in the use of the e-banking services. There is a need for awareness program for them (Shende & Khursange, 2013).

Consumers think that major advantage of mobile banking is anywhere and anytime banking (Wadhe & Ghodke, 2013). However, only about 1.5% internet user is using the internet banking. One of the study have found that in terms of e-banking, ATM services is adopted by most of the banks in Nepal, while mobile banking gaining the popularity but internet banking is still not available (Banstola, 2007). The most important obstacles that had impeded the use of it: the difficulty of the procedure for use of those electronic channels and lack of knowledge about the benefits that accrue to the client through use of these channels for various banking (Kolodinsky, Hogarth, & Shue, 2001).

Awareness about internet banking and its benefits and security were identified as the major reason behind lower utilization of internet banking among the customers. Whereas customer's education levels, their knowledge about the computer and internet, electricity problem and theft of password, and internet infrastructure in the country were identified as major challenges faced by the bank regarding the development of their online facilities (Khatri & Upadhyay-Dhungel, 2013).

METHODS AND MATERIALS

Applying post-positivist paradigm, deductive approach was used in the study. Multistage sampling was used from purposive area and three districts were selected from three zones. Simple random sampling was used to take opinion of commercial bank customers. Through universal used formula, sample size of 404 was determined. Questionnaire was developed after in depth study of related literature. Supervisors, experts and bank mangers suggested and updated the questionnaire. The pilot study was carried out and pursuant to the research questions were edited. Reliability and validity tests were also carried out properly. Primary data was taken from field survey and secondary data were taken from Nepal Rastra Bank reports, Banks' bulletin, website, books, journals, etc. SPSS 20.0 was used to analyze the data. Percentiles, mean, standard deviation, One away ANOVA, chi square tests were carried out to find the needs and expectations of customers. Significant difference was observed.

RESULT AND DISCUSSION

Sources of Information about Banking Services

Banks had lots of services. They should deliver to the customers. For the purpose 404 customers' view were presented below.

Table 1: Sources of Information about Bank Services

S.N.	Media	Response (%)
1	Newspaper	71.6
2	Radio/Television	62.2
3	Magazines	27.9
4	Internet	56.9
5	Cinema	20
6	Hoarding Board	56.6
7	Pamphlet	34.3
8	Poster	32.3
9	Relatives and friends	82.9
10	Employee of the banks	69.1

Source: Field survey (2016/17)

The above Table gives the source of information respondents are having about the bank. Newspaper is the source of information for 71.6% respondents. Similarly, radio/television is source of information for 62.2% of people. 27.9 % people collected information from

magazines, 56.9% from internet. Cinema, hoarding board, pamphlet, poster, relatives and friends & employee of the banks are also media for the source of information about the bank. Their respective share among participant was 20%, 56.6%, 34.3%, 32.3%, 82.9% & 69.1 %. From the above it is concluded that, the main source of information in the sample was relatives and friends.

Awareness About Banking Services

A total of 404 respondents were asked about their awareness about the bank services. The awareness status of customers was shown in the table.

Table 2: Awareness about Banking Services

Awareness about Banking Services					
	Frequency	Percent	Valid Percent	Cumulative Percent	
Valid	Fully Aware	1	.2	.2	.2
	Highly Aware	187	46.2	46.3	46.5
	Moderately Aware	144	35.6	35.6	82.2
	Somewhat Aware	72	17.8	17.8	100.0
	Total	404	99.8	100.0	
Total		405	100.0		

Source: Field survey (2016/17)

The above Table gives information on participant's awareness about banking. Only 0.2% or a single participant was fully aware about banking service. 187 people are highly aware. Its coverage is 46.2%. 144 people are moderately aware and it covers 35.6% and 72 people are somewhat aware and it is 17.8%. From above, it is concluded majority is highly aware about the banking service.

Table 3: Significance Difference of Awareness Level among Personal Background

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Gender)	8.596	1	8.596	15.670	.000
Between Groups (Districts)	1.221	2	.611	1.074	.343
Between Groups (Type of Banks)	3.615	1	3.615	6.444	.012

Source: Field survey (2016/17)

There is significant difference between gender and type of banks about banking services. It means that awareness level significantly differ between male and female likewise for the public and private banks. There is no difference between districts i.e., Banke, Dang, and Jumla.

Association of Sources of Information about the Bank

The awareness of bank services providing sources were given in reference of types of bank. The result is shown in the given table:

Table 4: Association of Sources of Information about the Bank

S. N.	Media		Value	df	Asymp. Sig. (2-sided)
1	Newspaper	Public	121.742 ^b	4	.000
		Private	78.405 ^c	3	.000
2	Radio/Television	Public	4.933 ^b	4	.294
		Private	44.210 ^c	3	.000
3	Magazines	Public	23.887 ^b	4	.000
		Private	35.362 ^c	3	.000
4	Internet	Public	96.460 ^b	2	.000
		Private	83.995 ^c	3	.000
5	Cinema	Public	28.195 ^b	4	.000
		Private	13.588 ^c	3	.004
6	Hoardings Board	Public	14.909 ^b	4	.005
		Private	24.558 ^c	3	.000
7	Pamphlet	Public	17.617 ^b	4	.001
		Private	50.289 ^c	3	.000
8	Poster	Public	12.058 ^b	4	.017
		Private	53.094 ^c	3	.000
9	Relatives and friends	Public	17.566 ^b	4	.001
		Private	32.147 ^c	3	.000
10	Employee of the banks	Public	28.195 ^b	4	.000
		Private	13.588 ^c	3	.004

Source: Field survey (2016/17)

This Table shows the association among the medium of providing information of bank services, customers' awareness on the basis of types of bank. There was no significant association among the sources of information about bank services and customers' awareness on the basis of both type of banks. The Table further shows that there is no significant difference between sources of providing awareness about bank services and awareness level of customers for public and private banks.

Strandvik *et al.* (2012) emphasized on customer's customer requests, i.e. being customer-oriented. It is not enough and that companies need to attend to buyers' latent and future needs. Customer orientation typically emphasizes generating and sharing intelligence about customers' customers and taking coordinated action to satisfy those needs, whereas requirement takes the

opposite stance and starts from the buyer and refers to how strategies and visions give rise to different buying prerequisites. Our result supports previous findings.

CONCLUSION

Relatives and friends, Newspaper, Magazines, Radio/Television, Cinema, Hoarding Board, Internet, Pam plate, Poster and Employee of the banks were the sources of information about the services provided by the bank. Majority of customers gained knowledge from relatives. The study showed that majority of respondents was aware about the bank services. Association between sources of information and customers' awareness were compared by types of bank. There was no significant association among the sources of information about bank services and customers' awareness on the basis of both type of bank. Tables show that there is no significant difference between sources of providing awareness about bank services and awareness level of customers having $p < 0.05$. This was for both public as well as private banks.

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EMPLOYEE ENGAGEMENT AND JOB SATISFACTION: AN EMPIRICAL STUDY OF BPOs

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ABSTRACT

Human resource department while ensuring the well-being of the employees pays attention to ensure employee engagement and job satisfaction for its employees. Organizations in recent times have been taking efforts towards employee engagement. They also seek to ensure maximum job satisfaction for their employees. Both these factors help to enhance the productivity of the employees and make their stay in the organization happy and meaningful. Employee engagement and job satisfaction go a long way in employee retention. Several studies have been conducted to study the relation between employee engagement and job satisfaction. Current research attempts to study the relationship between employee engagement and job satisfaction in BPOs in Mumbai region. Results show a positive relationship between employee engagement and job satisfaction.

Keywords: BPO, Employee Engagement, Job Satisfaction, Performance, Productivity.

INTRODUCTION

Organizations these days are concerned with getting better performance and maximum productivity from their employees. Thus they take every possible effort to constructively engage their employees. On one hand effort is taken by the organizations to ensure employee engagement and on the other hand they are also concerned about the amount of job satisfaction sought by these employees. Research scholars across the world have studied the concepts of employee engagement and job satisfaction. Most of these studies were conducted in banks, hospitality industry, information technology sector, manufacturing sector. The focus of this study is to understand the relationship between employee engagement and job satisfaction in Business Process Outsourcing (BPO) companies.

Human resources are very crucial assets for a BPOs. However BPOs also face the problem of attrition. Attrition in BPOs hovers around 40% and in some cases it is as high as 60% and in extreme cases even 100%. For the BPOs, talent attraction and talent retention are a major challenge. Employee engagement and job satisfaction play a very important role in retaining employees.

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LITERATURE REVIEW

Employee engagement has received greater attention in the past decade from the practicing managers as well as the academic community. Saks (2006) defines employee engagement as the extent to which an individual is attentive and absorbed in the performance of his/her roles. Saks (2019) provides an update and revision of the Saks (2006) model of employee engagement. Harter, Schmidt and Hayes (2002) define employee engagement as '*the individual's involvement and satisfaction with as well as enthusiasm for work*'. Thus employee engagement is the degree to which an individual feels involved and attracted to his job.

For decades the HR fraternity has been concerned about job satisfaction amongst its workforce. Hoppock (1935) defined job satisfaction as combination of psychological, physiological and environmental circumstances; it could cause a person say "I am satisfied with my job". Job satisfaction refers to the set of feelings and beliefs people possess about their job. It would range from extremely satisfied to extremely dissatisfied. Job satisfaction is closely related to the emotions and feelings of the employee towards his job and as a result of his job.

Yeh (2013) conducted a study on 336 hotel employees from 22 hotels of Taiwan. His study showed a positive relationship between work engagement and job satisfaction. A positive and significant relationship between work engagement and job satisfaction was observed in the study conducted by Ramos, Ales and Sierra (2014). This result is similar to other research studies (Alarcon & Lyons, 2011; Cervoni & DeLucia-Waack, 2011; Yanhan, 2013), which have shown a positive relationship between engagement and job satisfaction.

Vorina, Simonič & Vlasova (2017) examined the relationship between employee engagement and job satisfaction. The results confirmed a positive and statistically significant relationship between employee engagement and job satisfaction. The results of their study further revealed that there was no statistically significant difference between employee engagement and gender and there was no statistically significant difference between job satisfaction and gender. Garg, Dar & Mishra (2018) found positive relationship between job satisfaction and work engagement among managers at various hierarchical levels in private sector banks in India. Bhargava (2019) in her study on banking sector found that there was significant relationship between employee engagement and job satisfaction.

OBJECTIVE

The main objective of this paper was to study the relationship between employee engagement and job satisfaction in the BPOs.

Hypothesis :

On the basis of the previous research studies it was hypothesized that :

H_0 : There is no significant relationship between employee engagement and job satisfaction.

H_1 : There is a significant relationship between employee engagement and job satisfaction.

METHODOLOGY

The study was conducted in various BPOs in Mumbai region. The sample was obtained using probability sampling method. The total sample size was 352 respondents. The

demographic profile of the sample is as follows

Table 1: Demographic Profile of Respondents

Age	Frequency	Percentage
25-35	121	34
35-45	159	45
45-55	56	16
55 and above	16	5
Gender	Frequency	Percentage
Male	215	61
Female	137	39
Qualification	Frequency	Percentage
Diploma	59	17
Graduate	217	62
Post-Graduate	76	21

INSTRUMENTS

Employee Engagement : In this study, employee engagement was measured using Gallup's questionnaire which consisted of twelve questions.

Job Satisfaction : Minnesota's scale is very popularly used scale for measuring job satisfaction. For the purpose of this study, job satisfaction was measured using the smaller version of Minnesota's scale which consisted of twenty questions.

Data Analysis and Findings :

Questionnaire was used to collect the data. The data was further subjected to statistical analysis. The data was analysed using SPSS version 21.

Reliability Analysis :

The reliability was tested by Cronbach's alpha coefficients, which are used to check the internal consistency of the data. Results show that both the scales used in the survey were highly reliable.

Table 2 : Reliability Statistics – Employee Engagement

Cronbach's Alpha	No. of Items
0.813	12

As seen in Table 2, the reliability for the employee engagement scale is 0.813.

Table 3 : Reliability Statistics – Job Satisfaction

Cronbach's Alpha	N of Items
0.792	20

As seen in Table 3, the reliability for the job satisfaction scale is 0.792.

Correlation Matrix :

The data was further analysed using Karl Pearson's product-moment correlation coefficient. The correlations result between the variables studied is tabulated in Table 4.

Table 4 : Correlation Matrix

	Mean	S.D.	EE	JS
EE	3.5756	0.59351	1	0.608**
JS	3.2063	0.41317	0.608**	1

**. Correlation is significant at the 0.01 level (2-tailed).
P= .000
EE – Employee Engagement
JS – Job Satisfaction

The above Table shows mean values and standard deviation for both the variables under consideration. It also shows correlation between both the variables. As seen in the above Table, the correlation matrix shows that employee engagement and job satisfaction are positively correlated with each other. The p value is 0.000 which is less than 0.01. Thus we reject H_0 and accept H_1 i.e. to say '*there is a significant positive relationship between EE and JS.*'

DISCUSSION

The findings show an unequivocal relationship between employee engagement and job satisfaction. The study shows a significant positive relationship between employee engagement and job satisfaction. The findings of this study are in tune with the earlier research on employee engagement and job satisfaction.

In organizations, engaged employees lead to higher outcomes. Engaged employees also lead to higher service, quality, and productivity, higher customer satisfaction, increased sales (Kruse, 2012). Job satisfaction is the sense of happiness one derives from the job. Organizations must take efforts to increase employee engagement and create conducive environment so that the employees enjoy greater job satisfaction. BPOs should endeavour to create long term lucrative opportunities for designing career path for employees. Job Satisfaction of the employee's would be enhanced by having a dynamic career path, and in turn it helps to retain outstanding and highly performing talents (Monis & Sreedhara, 2011). There is further scope to study employee engagement in relation to intrinsic and extrinsic job satisfaction.

CONCLUSION

In today's dynamic global environment, wherein organizations face uncertain economic climate, both job satisfaction and employee engagement are important for business sustainability. The study shows a positive relationship between employee engagement and job satisfaction in the select BPOs in Mumbai region. Employee engagement is the antecedent of job satisfaction. Thus increase in employee engagement leads to higher job satisfaction. The limitation of the study is that it was limited to geographical region of Mumbai and only to

select BPOs. The implication of the study is that if organizations take more efforts to enhance employee engagement amongst their employees, these employees will derive higher job satisfaction.

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CRITICAL ANALYSIS OF OPERATING RATIOS OF PRIVATE SECTOR LIFE INSURERS : PERSPECTIVES OF POLICY BUYERS IN INDIA

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ABSTRACT

This paper analyses the fundamental financial performance through measurement of operating ratios of private sector life insurers in India. The paper aims to contribute to the study that will help life insurance policy buyers to basis their informed decision in the process of selecting one of the best Pvt. Sector life Insurance Company from the given options before they choose any life insurance product for their portfolios. The industry specific ratios which are applied to insurance sector have been used as a tool to measure the performance of two companies. The information used in the study has been extracted from stand alone financial statements of two real and closely competitive private sector life insurance companies and operating ratios applied in the insurance industry has been computed. As the study also aims to educate the policy buyers by presenting the information in a simplified manner therefore, implications of this paper are high to sensitize the managers in the sector.

Keywords: Financial Statement, Life Insurance, Policy, Private Sector, Ratios

INTRODUCTION

The life insurance, by virtue of its nature, is an intangible product and involves invisible trade. An insurer under the life insurance contract assumes the life-risk of the insured by undertaking to indemnify the loss/es in consideration of premium received (front-end) and the collection so received by the insurance company strengthen the pool of company's investible

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funds as a principal source of revenue in the policy holder's account or technical account. The advancement of shareholder's account or non-technical account of life insurance companies as well as probability of servicing to the policy claims depend on residuals left by their technical accounts. Hence, the businesses of Life Insurance Companies are capital intensive, claims sensitive, balance sheet driven and require adequacy of liquidity for a successful and sustainable operation.

While complying with the requirements of Schedule A of the Regulations, 2002 in the preparation of Financial Statements, the insurers practice the mechanism to transfer the risk through reinsurance. Though, this strengthens the company intends to assume greater risk but results into significant part of the capital to remain off-balance sheet and pose a complexity to the users of financial statement to understand unlike that of financial statement of non-life insurance companies.

Adequacy of capital for a successful insurance operation is a must. Capital is a scarce commodity and it comes at a significant cost. Since debt capital appearing on the balance sheet involves constraint and cost, insurers often tend to increase their net worth to transact insurance business in a frequently competitive market by taking recourse to 'Off-Balance Sheet Capital' obtained through reinsurance and further down the line by retrocession.

The complexity to read the balance sheet of an insurance company arises because of its significant reliance on 'Off-Balance Sheet Capital'. Regulatory compliance requires an insurance company to arrange first a proper risk transfer mechanism which is known as reinsurance facility for shedding off the additional exposure beyond its limit of retention on any one risk. This is known as 'Off-Balance Sheet Capital' as this is a kind of capital that is not visible on the balance sheet but remains obscured that provides financial strength to the company to assume more risks to augment its business.

On the other hand, to understand the fundamental financial performance of an entity and its peers engaged in the business of life insurance, the assessment of operating financial ratios is generally applied that proves to be a 'means' but not an 'end'. The investment in insurance companies is made in two different forms. One type of investment comes from those who buy the equity or debt instruments of insurance companies and others are those who buy the insurance policies.

REVIEW OF LITERATURE

In order to provide for diagnostic solutions to the health of the life insurance sector, several indicators have been suggested in the background paper of the IMF on *Financial Soundness Indicators, 2003*. Evaluation of Financial Soundness of Life Insurance Companies in India has been researched by K. Alamelu in 2011. Fola and Ansari (2014) have worked on Indian life insurance performance and financial soundness of the life insurance companies. They analyzed financial ratios and asset worthiness of private and public life insurance companies in India. C K Naidu and Dr. C Paramasivan (2015) in their paper, "*A Comparative Study of Public & Private Life Insurance Companies In India*", made attempts to study the Public & Private Life Insurance Companies and compared the perception of customers in terms of service quality and analyzed the performance of public and private life insurance companies.

Dr. N. M. Leepsa and Dr. Sabat Kumar Digal(2015) in their paper “*The Insurance Industry in India: A Comparative Analysis of The Private and Public Players*” have researched on the characteristics of Insurance Industry which was based on strength and weakness of Insurance Industry in India. In their paper on privatization of life insurance in India, M.U. Ahmad and S. Siddiqui emphasized on the need to study the investment pattern of private life insurance companies and the performance trends individually as well as against the industry particularly in the post-insurance liberalization era. Most of the studies concluded so far are found either with a very generic view or inclination of such researches has been towards improving the effectiveness of organizations. The recommendations made and scope for work left over have not much differences. No more studies could be found which would have given a direction to the buyers of life insurance products and which could help them decide about a criteria for selection of L1 products.

PRIVATE SECTOR INSURANCE INDUSTRY OVERVIEW

The private sector life insurance service providers in India were allowed to open up their businesses in the year 2000. The private participants could take up only 39% market share by FY 2009 in new business premium segment. Between FY 2009 and FY 2013, the private insurance sector experienced 3% decline, while LIC continued to grow at 9% CAGR, resulting in a slide in the private sector’s market share. Year 2017 has seen a vibrant expansion and growth of life insurance sector mainly due to the introduction of the new private insurers as well as a rise in the demand of new products offered with pocket-friendly premiums. With the increase in income and growth of purchasing power as well as household savings, the life insurance sector in India is expected to introduce further innovative products and distribution, improvised claims management and regulator’s stress on market supervision. However, nothing can substitute the informed decision of policy buyers when protection of savings is at stake. Buying a life insurance policy from a company which is sound in its practices and managing its resources is the preference for the buyer.

OPERATING RATIOS OF INSURANCE COMPANIES BY POLICY BUYERS

‘Insurance is a more commonly known concept that describes the act of guarding against risk. An insured is the party who will seek to obtain an insurance policy while the insurer is the party that shares the risk for a paid price called an insurance premium’. Since, the investment objectives of two types of investors are found to be different in the insurance industry, hence one set of ratios may not suit the goals of those types of investors whose investment objective differ. Apart from generally applied set of ratios such as Profitability, Ratios, Liquidity Ratios, Solvency Ratios and Activity Ratios, there are standard ones for insurance sector. If the industry specific ratios are applied, the assessment results become more realistic. Therefore, particularly what is needed by a proposer of life insurance product is to understand in advance the difference between the two investment practices i.e. investment in the equity or debt product and that of investment in a life insurance policy. The names of two real companies have been replaced by EX-LI Pvt. Ltd. and BY-LI Pvt. Ltd. for the reasons that their individual integrity and market positions may remain unaffected because of sensitive information in this research paper .

The ratios which are applied in the insurance industry are as below:

Comparative Persistency Ratio of EX-LI Pvt. Ltd. and BY-LI Pvt. Ltd.

Persistency refers to a policy's being remaining in force without lapsing or being replaced by policies of other insurers. Persistency Ratio refers to percentage number of policy holders paying the premium over Net active policyholders. It is calculated by dividing the Number of policyholders paying the premium x 100 by the Net active policy holders. On the basis of insured's persistency in renewing of their policies every year, normally over the different intervals say-13th month, 25th month, 37th month and 61st month, the customer's trust in the insurer's long term products and services can be measured. A high persistency ratio is an indicator of large base of loyal customers satisfied with the product and its utility, post-sales service of the company, and paid or accrued bonus or returns etc., whereas low persistency ratio indicates inability of the company to retain customers. This method calculates the leakage from the preceding year and not from the year of sale. Persistency ratios have been calculated in accordance with original premium method as prescribed by IRDA in 2014 and hence its computation is considered with a lag of one month.

Table 1: Comparative Persistency Ratio

Year	EX-LI Pvt. Ltd. (Percentage)					BY-LI Pvt. Ltd. (Percentage)				
	13 th Month	25 th Month	37 th Month	49 th Month	61 st Month	13 th Month	25 th Month	37 th Month	49 th Month	61 st Month
2014	70.44	72.03	62.27	54.04	19.16	60.10	60.70	64.20	53.30	43.50
2015	72.97	65.05	67.87	61.67	37.14	62.17	53.71	56.61	41.58	38.87
2016	79.09	67.33	61.20	66.17	43.61	64.69	56.52	49.61	52.08	35.45
2017	80.88	73.34	63.90	58.31	56.79	71.45	60.18	52.21	47.30	47.05

Findings: From the Table 1, it can be seen that from the Year 2014 to the Year 2017, the 13th month persistency ratio of EX-LI Pvt. Ltd. has improved by 10.44% and that of BY-LI Pvt. Ltd. by 11.35%. On comparing 25th month ratio, the EX-LI Pvt. Ltd. recovered its position with 1.3% increase from the Year 2014 after going down by nearly 7% in the Year 2015 and moving up by 2.32% in the following Year 2016. The similar changing position could be seen in case of BY-LI Pvt.Ltd.'s 25th Month Persistency Ratio while it could manage to regain its 60%. The data comparison of 37th month and 49th month showed that where EX-LI Pvt. Ltd. could manage to recover its position after variations with slight improvement in earning premiums whereas BY-LI Pvt. Ltd. remained distant from its own position as compared to the Year 2014. With regard to long term persistency ratio i.e. on 4-years basis, the EX-LI Pvt. Ltd. achieved nearly double of the premium as a result of increase in the number of policyholders and while maintaining its consistent growth it recorded nearly three times of the persistency ratio in comparison with the Year 2017.

Comparative Solvency Ratios of EX-LI Pvt. Ltd. and BY-LI Pvt. Ltd.

Solvency means the capacity to meet long term obligations. In the extreme situations, the claims can be settled by the company out of its buffers. Therefore, it is the high level

of solvency ratio that minimises the bankruptcy risk of an Insurance company but it is not necessarily the indicator of financial health of the company. A higher position of solvency ratio signifies that the chances of settling the claims are greater. India's insurance regulator has prescribed guidelines with respect to solvency ratio that require the companies to maintain 150 % solvency ratio. The solvency ratio in reference to insurance companies is the value reached at by dividing the amount of available Solvency Margin to the amount of required Solvency Margin. The ASM is the value of the company's assets over liabilities, and RSM is based on net premiums.

Table 2 Comparative Solvency Ratio

Year	EX-LI Pvt. Ltd.	BY-LI Pvt. Ltd.
2014	194%	186%
2015	196%	205%
2016	198%	211%
2017	192%	200%

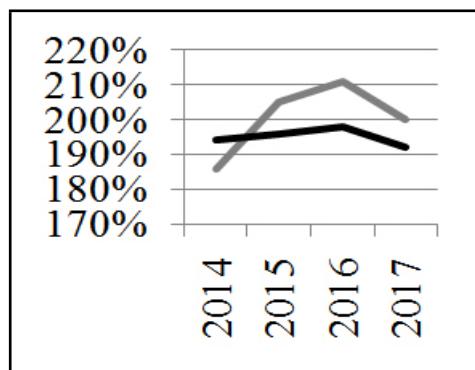


Figure 1: Comparative Solvency Ratio

Findings: In reference to the Table 2 and Figure 1, the Solvency ratio of both the companies stood sound as against the required mandate of 150% by IRDA. However, it can be found that the two companies have added strength to strength from the Year 2014 to 2016 by consistently moving up with solvency but in the Year 2017, the decline was registered. The reason of 192% of solvency in the Year 2017 was supported by justification disclosed in the financial statement of EX-LI Pvt. Ltd. which showed that the ratio accounted after distribution of the dividend was up to Rs. 264 Cr.

Comparative Combined Ratio:

Combined ratio is used to measure the profitability of an insurance company that indicates how well it is performing in its daily operations. It is a reflection of the underwriting expense as well as operating expenses structure of the insurer. Lower the combined ratio on scale of 100 is always better as it indicates that the expenses or losses of the insurance company are lesser than its earned premium revenue. If the combined ratio is more than 100%, it usually means the cash outflow of the insurance company is more than its earned premium, which is not a

healthy financial condition. However, the higher combined ratio does not mean the company is running at a loss if the ratio does not include earnings from investments or investment income. The combined ratio is calculated by summing the incurred losses and expenses and dividing the sum by the total earned premium.

Table 3 Comparative Combined Ratio

Year	EX-LI Pvt. Ltd.	BY-LI Pvt. Ltd.
2014	17.47%	26.4%
2015	16.06%	23.48%
2016	18.00%	22.02%
2017	18.26%	23.13%

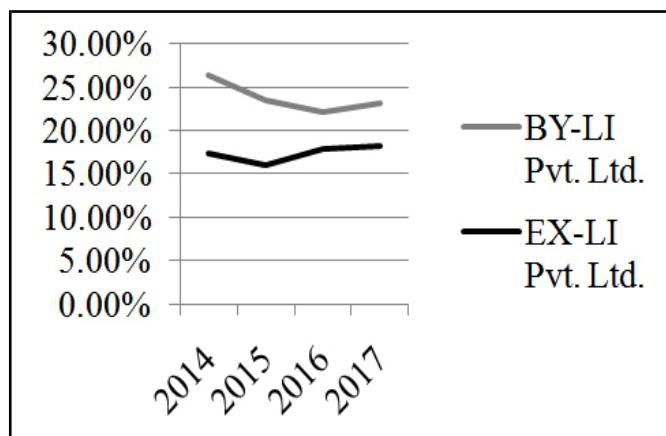


Fig. 2 Comparative Combined Ratio

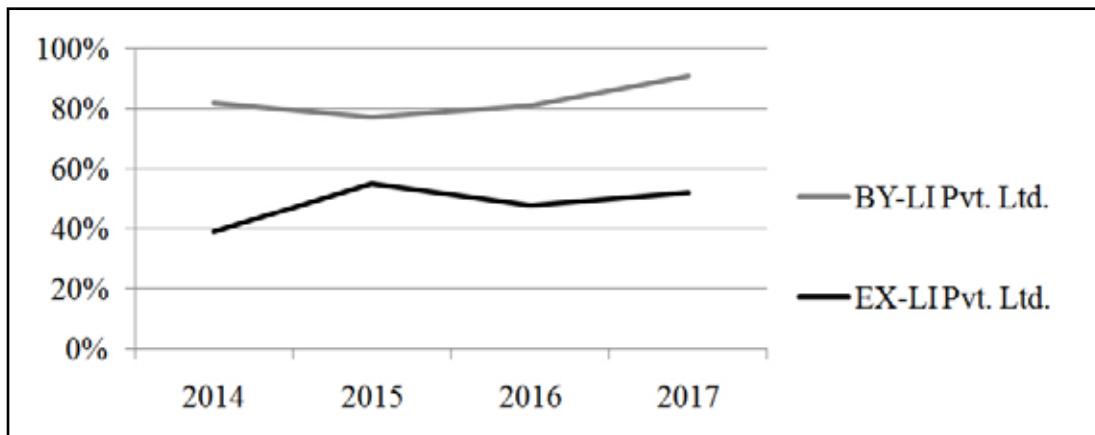
Findings: The data from Table 3 and Fig. 2 as above indicates that there has been an increase in the percentage of combined ratio of EX-LI Pvt. Ltd. in the Year 2017 as against in the Year 2014 whereas BY-LI Pvt. Ltd. could manage to bring it down significantly. Year 2015 was the focus year for both the companies to cut short the expenses. On comparing both the companies adopted a better control over the expenses or losses and can be seen in case of the EX-LI Pvt. Ltd. during the respective years.

Comparative Incurred Claims Ratio i.e. Net Claims Incurred / Net Earned Premium

Insurer's ability to pay claims is calculated by dividing the total value of all claims incurred or paid by the company by the total amount of premium collected in a financial year. A healthy ratio is between 75 & 90%. An ICR greater than 100% may not be a good indicator. It shows that a large part of the premium is used to cover actual risk transfer but it is also a function of the company's ability to avoid fraud and select business. A higher ICR can be seen in a new company which may not have earned substantial premium in the initial years of operation and faced a high rate of claims. The ICR does not reflect the company's process of claim settlement. A company with a good ICR can have a long claim settlement process.

Table 4: Incurred Claim Ratio

Year	EX-LI Pvt. Ltd. (Rs. in '000)			BY-LI Pvt. Ltd. (Rs. in '000)		
	Net Claims Incurred	Net Earned Premium	Ratio	Net Claims Incurred	Net Earned Premium	Ratio
2014	46,512,088	119,764,325	39%	37,882,146	46,448,513	82%
2015	80,882,983	147,624,515	55%	39,194,221	50,683,663	77%
2016	77,547,552	161,787,796	48%	43,573,383	54,117,352	81%
2017	99,739,014	192,748,644	52%	50,110,557	55,335,476	91%

**Figure 3: Incurred Claim Ratio**

Findings: Reference to the Table 4 and Figure 3 above, the Incurred Claim Ratio of EX-LI Pvt. Ltd. ranged between low at 39% in the Year 2014 and higher at 55% in the Year 2015 which slowed down from there at 48% and 52% in the Years 2016 and 2017 respectively, and hence incurred less amount of claims, whereas, BY-LI Pvt. Ltd. recorded a comparatively higher side of ICR that was calculated low at 77% in the Year 2015 and high at 91% in the Year 2017. It clearly indicates that EX-LI Pvt. Ltd had higher retention of premium as surplus and whereas BY-LI Pvt. Ltd. retained lower percentage of premium. On the other hand, it can be said that EX-LI Pvt. Ltd. incurred less amount of claims as compared to its competitor. The interpretation should not be limited to the above but it would have been possible that the EX-LI Pvt. Ltd. had put objections over the claims and so it did not qualify the claims and hence the incurred claim ratio was lower which is also not a good indicator in favour of policy holders.

Commission Expense Ratio

Insurance companies get business through agents; these agents receive commission on the basis of amount of premium they generate for insurance company.² The commission paid to agents is shown as a debit (expense) in the revenue accounts. Sale of life insurance product is a subject of solicitation through agents against commission which is paid to them out of written premium during a particular period. The commission payable to life insurance

agents ranges from 15% to 35% on first year premium. The min-max limit applies in cases of policies having premium payment terms of 5 years and 12 years or more respectively and the same decreases in following years which ranges between 7.5 % to 5%. When the Commission Expense Ratio is low it usually means a lower premium is called to be paid by policy buyers and a high commission expense would translate to lower discounts offered. Therefore, lower the commission expense ratio, it is considered to be the better. After a threshold, the higher the commission expense ratio, the lower the discount offered, leads to a higher premium paid.

Table 5: Commission- Expense Ratios

Year	EX-LI Pvt. Ltd.	BY-LI Pvt. Ltd.
2014	4.26%	4.86%
2015	4.21%	4.45%
2016	4.29%	3.90%
2017	4.1%	4.45%

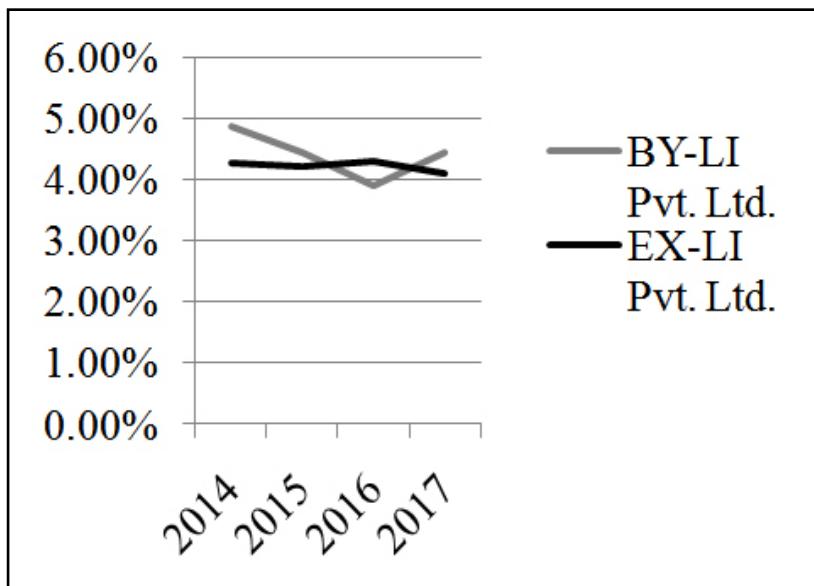


Figure 4: Commission- Expense Ratios

Findings

From the Table 6, Figure 5, it can be seen that there was a decline in the Commission Expense Ratio of EX-LI Pvt. Ltd. from 4.26% in the Year 2014 to 4.1% in the Year 2017 as against this ratio of BY-LI Pvt. Ltd which could reduce from 4.86% in the Year 2014 to 4.45% in the Year 2017. The reason for decline in this ratio of EX-LI Pvt. Ltd. could be an increased emphasis on digital distribution whereas sudden decline from 4.45 % in the Year 2015 to 3.90% in the Year 2016 and again steep rise to 4.45% in the Year 2017 depicts the inconsistency adopted in the policy.

Comparative Claim Settlement Ratio

A claim occurs when a policy falls due for payment. Unlike general insurance, the claim in life insurance arises on death or maturity of policy³. From accounting viewpoints while calculating the outstanding claim at the end, the claim intimated as well as claim intimated and accepted both are considered by the company. Claim settlement ratio, being it a measure of the insurer's reputation indicates how many claims a company has settled against the number of claims received from policy holders. It is calculated as the total number of claims received against the total number of claims settled. This ratio is just an average of all types of life insurance policies. Higher Claim settlement ratio reflects the greater the chances of settlement of a claim. It is prudent to cumulatively analyze the past few years' claim settlement data to assess the trend about a particular insurer. This is important ratio especially before buying pure risk covers such as term plans. However this ratio is taken for consideration with all other parameters such as quality of service, policy features, terms and conditions, etc. before making a purchase decision. This ratio is not a sole criterion in judging the performance of a life insurance company in isolation.

Table 6: Claim- Settlement Ratios

Year	EX-LI Pvt. Ltd.	BY-LI Pvt. Ltd.
2014	94%	88%
2015	91%	95%
2016	95%	88%
2017	98%	95%

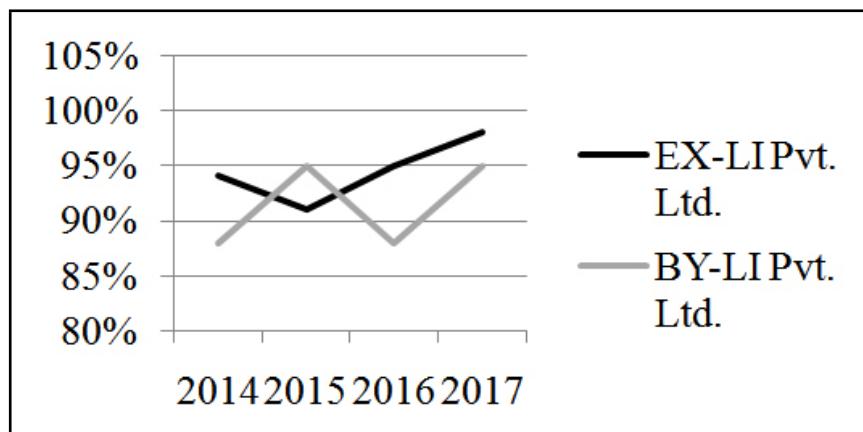


Figure 5 : Claim- Settlement Ratio

Findings

From the Table 6 and as showed in the line chart in Figure 5 above, a four year average age of pending claims for BY-LI Pvt. Ltd. as well as EX-LI Pvt. Ltd. is 45 days. CSR of both companies was lower in the Year 2015. After a 3% slide in CSR of EX-LI Pvt. Ltd. from Yr the Year 2014 to the Year 2015, the growth in settlement was consistently recorded as

comparative to BY-LI Pvt. Ltd. which followed an even variations consecutively. There might be impersonation, misrepresentation and fraud claims which are not settled by the insurers as they are not responsible for such claims and therefore the ratio declines due to such cases.

Consolidated Grid of Four Year's Average

Table 7: Four Year's Average Ratios

Ratios	Acceptance level	EX-LI	BY-LI
Persistency Ratio -Long Term	Low (61 month)	39.17	41.21
Persistency Ratio -Short Term	High(13 month)	75.75	64.6
Solvency Ratio	Above 150%	195	200.5
Combined Ratio	Below 100	17.4	23.75
Incurred Claim Ratio	Below 90%	48.5	82.75
Commission Expense Ratio	Very Low	4.21	4.41
Claim Settlement Ratio	Very High	94.5	91.5

RECOMMENDATION

The criteria for selection of a life insurance policy should not be only for the benefits offered by the company to a purchaser. Broad level latent risk factors though they are mostly transferred by the insurance companies to re-insurer but with the help of certain ratios which have been used as example in this paper may be known which prove to be handy. The assessment of operational and financial risk of a company by using ratios guides the user on how a company is likely to remain committed or to turn risky. Since ratios highlight the past track records of the company's business operations, they become handy for a decision to purchase a policy or not. This exercise is time taking as the data is not found in the report which may be ready for re-use or re-arrange meaningfully. But it is always prudent to use the ratios and thereby, policy buyers may protect their savings from potential investment in a high risk profile private life insurance company which might otherwise produce no more as it is printed in the brochures or as it is informed by the agents. Also, it may be recommended to the companies that their prospective policy buyers may reasonably infer better decisions, if they maintain consistency in the manner of presenting data and information in brochures, annual reports and their web portals.

ENDNOTE

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