Chemistry and Materials Research
ISSN 2224- 3224 (Print) ISSN 2225- 0956 (Online)
Vol.7 No.1, 2015 

# Spectrometric Detection of Organic Compounds and Toxicity of Ethanolic Leaves Extracts of Prosopis Juliflora

Wamburu R.W.[1*] Kareru P.G.[1] Mbaria J.M.[3] Nyaga G.[1] Rechab S.O.[1]
1.Chemistry Department
2.Research, Production and Extension Division, Jomo Kenyatta University of Agriculture and Technology
3.University of Nairobi
P.O Box 62000-00200, Nairobi, Kenya
E-mail: waitkaburu@gmail.com

**Abstract**
Spectrometric detection of saponins, tannins and alkaloids in *Prosopis juliflora* using Fourier Transform Infrared (FTIR) spectroscopy is reported in this paper. Crude dry plant powders and corresponding ethanolic extracts were mixed with potassium bromide (KBr) powder and compressed to a thin pellet for infrared examination. The plant powders, ethanolic extracts and leaves ethanolic extract (LEE) fractions exhibited characteristic infrared spectra due to various functional groups –OH, -C=O, C-H, and C=C absorptions. Phytochemical analysis confirmed the presence of saponins, tannins and alkaloids in the tested specimens. *Prosopis juliflora* whole plant parts were used as a reference sample. Toxicity and safety levels of *P. juliflora* were also investigated. Acute and sub-acute toxicity of *P. juliflora* ethanolic leaves extract was evaluated using *Swiss albino* rats. All clinical signs and symptoms were recorded within 24 hours. These results indicated that direct detection of bioactive compounds was possible by infrared analysis. Toxicity symptoms were moderately observed and post mortem did not show any major gross effects on the internal organs.
**Keywords:** *Prosopis juliflora*, infrared examination, potassium bromide, acute and sub-acute toxicity, clinical signs, doses, symptoms.

## INTRODUCTION

Plants are used for various purposes in different parts of the world. Their usefulness can be in the form of food, shelter, textile, medicine and many more (Fabeku, 2006). Exploring the pharmacological potentials of plants for both preventive and curative therapies is an age old concept. Records of indigenous knowledge from various parts of the world illustrate an age long tradition of plant being a major bio-resources base for health care. *Prosopis juliflora* is an evergreen tree native to northern South America, Central America and the Caribbean (Pasiecznik *et al.,* 2004). It is fast growing, nitrogen-fixing and tolerant to arid conditions and saline soils (Anonymous 2003, Pasiecznik *et al.,* 2004). In Kenya *P. juliflora* was first planted in the beginning of the 1970s to rehabilitate a quarry in Bamburi near Mombasa (Ebenshade & Grainger 1980, Maghembe *et al.,* 1983). In the early 1980s *P. juliflora* was introduced in the Lake Baringo area through the Fuelwood Afforestation Extension Project (FAEP), the major objectives being involving the local people in tree planting to overcome problems such as lack of firewood and overgrazing (Kariuki 1993, Lenachuru 2003).

*Prosopis juliflora* pods which are high in protein and sugars may be important fodder for livestock, and / or food for humans. In the semi-arid areas of north eastern Brazil (de Barros *et al.,* 1988), it partly offsets fodder scarcity during the dry season. Results of feeding trials indicate that rations for goats, sheep, beef cattle and dairy cattle can give very good weight gains and/or milk production when about 60% of the diet consists of ground *Prosopis* pods. The flowers, leaves and fruits are reported to contain protein, fat, carbohydrate, fiber, Calcium, and Phosphorus (FAO, 1992). Analysis of the fruit also reveals presence of tannin-like material. Mesquite gum readily hydrolyses with dilute sulfuric acid to yield L-arabinose, D-galactose and 4-o-methyl-D-glucuronic acid at 4:2:1. Owing to the high content of arabinose, the gum is an excellent source of sugar. Roots contain 6–7% tannin, bark 3–8.4%, and dry wood 0.9%.

*Prosopis juliflora* is known for its medicinal value and many alkaloids such as juliflorine, julifloricine and julifloridine (Ahmad *et al.,* 1978), juliprosine (Daetwyler *et al.,* 1981), juliprosinine and juliflorinine (Ahmad *et al.,* 1989 a, 1989b), benzene insoluble alkaloidal fraction (containing two major and three minor alkaloids) (Ahmad *et al.,* 1989a, 1989b) have been isolated and their biological activities *in vitro* have been demonstrated. Antifungal, plant growth inhibiting and DNA binding alkaloids such as tryptamine, piperidine, phenethylamine and juliprosopine and their isomers have been isolated from the leaves of *P. juliflora* (Tapia *et al.,* 2000). The alkaloids 5-hydroxytryptamine and tryptamine are reported from this species (Simpson, 1977). *P. juliflora* leaves are commonly used to treat eye conditions, open wounds and dermatological ailments. Acting much as antacid, it can also treat digestive problems. It has soothing, astringent, and antiseptic properties (Davidow, 1999). The leaves are also reported to contain crude protein levels of 14-22%, crude fibre 21-23%, nitrogen free extract 43-50%, calcium 1.5% and phosphorus 0.2% while mineral content is directly related to the levels of minerals in the soil (Pasiecznik *et al.,* 2001). Bark extractives exhibit antifungal properties (Càceres *et*

 

*al.,* 1995). The remarkable economic and physiological characteristics of *P. juliflora* make it a prime contributor to the development of many arid regions, especially if its invasive habit is controlled and the thorns that limit its widespread acceptance are controlled. Efforts are underway in different parts of the world to moderate these unwanted attributes. New erect *Prosopis* clones with small thorns and high production of highly palatable pods have been identified in Peruvian field trials (Felker, 2003). Toasted seeds are added to coffee. Bark, rich in tannin, is used for roofing in Colombia. The gum forms adhesive mucilage, used as an emulsifying agent in confectionary and mending pottery. Roots contain 6–7% tannin, which might discourage Rhizobia (Bressani, 1977). *Prosopis* leaves contain various chemicals known to affect palatability to livestock, but also suppress the germination and growth of crops, weeds and other trees.

Owing to growing demand for herbals, the current need is to intensify research in the field of medicinal herbs and to get authentic information on the subject. This study aimed at investigating the phytochemical properties of the leaves, pods, barks and roots extracts from sequentially extracted samples using solvents of differing polarities and evaluate the acute and sub-acute toxicity in rats.

## 2.0 Materials and methods

### 2.1 Collection and identification of plant specimens

The plant specimens were collected from Marigat district of Rift Valley Province, Kenya. The voucher specimens were deposited in the Botany department laboratory of Jomo Kenyatta University of Agriculture and Technology. Authentic samples were air-dried under the shade and ground into a fine powder, and stored in airtight plastic containers.

### 2.2 Phytochemical screening

This was performed using standard procedures (Sofawara, 1993; Trease *et al.,* 1989; Harborne, 1973; Siddiqui and Ali, 1997). Different extracts were tested for tannins, alkaloids, saponins, flavonoids, steroids, terpenoids, anthraquinones, reducing sugars and glycosides. The results obtained were recorded in tabular form Table 1.

### 2.3 Infrared Spectra

A little powder of plant specimen was mixed with KBr salt, using a mortar and pestle, and compressed into a thin pellet. Infrared spectra were recorded as KBr pellets on a Schimadzu FTIR Spectrometer 8000 series, between 4000 – 500 $cm^{-1}$. Infrared absorptions were recorded in tables 2 and 3.

### 2.4 Acute Toxicity Tests of *P. juliflora* Leaves Ethanolic extracts (LEE)

22 Wistar *Albino* rats were obtained from random breeding in a closed colony from the animal house at Jomo Kenyatta University of Agriculture and Technology (JKUAT). They were kept in a temperature-controlled environment (23 ± 2ºC) with a 12 h light-dark cycle. Food and water were provided *ad libitum*. They were acclimatized for 7 days before the dose administration. The doses selected were 175mg/kg, 550mg/kg, 1750mg/kg, 2000mg/kg and 5000mg/kg. All the tests were conducted according to OECD 425 Guidelines procedures i.e. “up and down procedures”. The test substances were administered orally in a single dose using an intubation cannula.

## 3.0 Results

### 3.1 Phytochemical Test

The total extractability of the *P. juliflora* leaves was 12.06% while that of the ethanolic leaves were 6.94%. The extracts were greenish brown, while its consistency was viscous to semisolid on standing. This low yield of the leaves extracts indicates that it is poorly absorbed in the gastrointestinal tact. Table 1below shows the phytochemical test results for saponins, tannins and alkaloids in the samples under investigation. In quantification, alkaloid were found to contain 4.390±0.959%, saponins was 4.3035±0.2210% while tannins was 1.051978±0.0703%. The presence of these secondary metabolites is evidenced by the pharmacological use of the leaves extracts. The leaves have been used to make eyewashes to treat pink eye. It is also used to treat Intestinal problems such as diarrhea and empacho (Davidow, 1999). They can also be prepared to treat headaches, painful gums and bladder infection. A poultice of leaves is used for red ant stings. Leaves can serve as an emetic or system cleanser (Kay, 1996).

### 3.2 Infrared Spectra

The Infrared absorptions results were recorded in tables 2 and 3.

### 3.3 Acute toxicity study

During acute toxicity test, *P.juliflora* LEE was administered at dosage levels of 175 mg/kg, 550mg/kg, 1750mg/kg, 2000mg/kg and 5000mg/kg, once orally to five different groups. The test used 22 rats and only two

 

deaths were observed at 1750mg/kg dosage level. At this dosage level two extra rats per sex were treated to confirm the lethality of LEE and they all survived with only minor observable clinical symptoms of toxicity. No more death was noted even at the higher doses. The no-observed-adverse-effect level (NOAEL) for *P. juliflora* LEE administered was 1750 mg/kg while the minimum lethal dose and the estimated $LD_{50}$ was > 5000 mg/kg. The clinical signs observed included: - hypo-activity, pilo-erection, loss of appetite, salivation and hyperventilation (i.e. stress symptoms), nasal allergy and general body weakness. These signs also varied depending on the dosage used (i.e. they were more pronounced at the doses of 2000mg/kg and 5000mg/kg) as compared with the other lower doses. All the signs reversed within the first 72 hours observation period. At the end of the observation period all the rats were humanely sacrificed and a gross morphological observation was made on some selected tissues. There were no major variations on their structure and texture. The rat that died was noted to have a bloated stomach, anemic and with mild liver inflammation which could be due to malnutrition. The gastrointestinal tract had signs of mild inflammation. The results are as shown in table 4 below.

**Discussions**

A special feature of higher plants is their capacity to produce a large number of organic chemicals of high structural diversity. Phytochemical analyses of *Prosopis juliflora* gave positive results for saponins, tannins and alkaloids. These results were confirmed by infrared absorptions recorded. The FTIR spectra for saponins showed characteristic infrared absorbance (Table 2) of the hydroxyl group (-OH) ranging from 3472 $cm^{-1}$ ($F^C$) to 3159 $cm^{-1}$ (SEE); C-H ranging from 2932 $cm^{-1}$ (*pods powder*) to 2318 $cm^{-1}$ ($F^B$); C = C absorbance ranging from 1643 $cm^{-1}$ (FC) to 1616 $cm^{-1}$ (REE); C=O ranging from 1724 $cm^{-1}$ ($F^A$) to 1701 $cm^{-1}$ ($F^B$). Oligosaccharide linkage absorptions C-O-C were evident between 1092 $cm^{-1}$ ($F^A$) to 1042 $cm^{-1}$ (root powder). C=C-$C_{str}$ aromatic absorptions were characterised from 1555 $cm^{-1}$(leaves powder) to 1404 $cm^{-1}$(LEE).

The existence of one or more aromatic rings in a structure is normally readily determined from the C-H and C=C-$C_{str}$ ring-related vibrations (Coates, 2000) which are common in the organic metabolites investigated. These bioactive components have potential roles in health care and can be used to synthesize chemicals for new drug development. Drugs are derived from substances, such as alkaloids (e.g., caffeine, from the coffee shrub—Coffea arabica—used as a stimulan), glycosides (e.g., digoxin and other digitalis glycosides, from foxglove—Digitalis spp.—used to treat heart failure), alcohols, esters, aldehydes, or other constituents or mixtures of constituents isolated from the plant or animal (.Monika *et al., 2008). Prosopis juliflora* has many alkaloids such as juliflorine, julifloricine and julifloridine (Ahmad *et al.,* 1978), juliprosine (Daetwyler *et al.,* 1981), juliprosinine and juliflorinine (Ahmad *et al.,* 1989 a, 1989b) which have similar infrared functional group absorptions characteristics as above. The above infrared functional group absorptions characteristic of saponins were cited in literature (Kareru *et al.,* 2007, Kirmizigul *et al.,* 2002 among others. Saponins are a large family of structurally-related compounds of steroid or triterpenoid aglycone (sapogenin) linked to one or more oligosaccharide moieties by glycosidic linkage. The presence of both polar (sugar) and nonpolar (steroid or triterpene) groups provide saponins with strong surface-active properties (Makkar *et al.,* 2007). Their physiochemical and biological properties feature structural diversity, which have led to a number of traditional and industrial applications (Martin *et al.,* 1999).

According to Globally Harmonized Classification System for Chemical Substances and Mixtures (GHS), when a main study with starting dose of 5000 mg/kg is used, and there is no mortality observed (no toxicity) then the substance will be considered ***unclassified*** (OECD 420, 2001) According (Loomis, 1996) and (Pascoe, 1983), the systems for the classification of the toxicity of compounds can be based on their $LD_{50}$ values. Their classifications are as shown below in table 5.

**Table 5**: Systems for the classification of the toxicity of compounds

| **Category** | **$LD_{50}$ (mg/kg)** | **$LD_{50}$ (mg/kg)** | **Classification** |
|---|---|---|---|
| **Extremely toxic** | 1 or less | < 5 | Super toxic |
| **Highly toxic** | 1 to 50 | 5- 50 | Extremely toxic |
| **Moderately toxic** | 50 to 500 | 50- 500 | Very toxic |
| **Slightly toxic** | 500 to 5000 | 500- 5000 | Moderately toxic |
| ***Practically non-toxic*** | ***5000 to 15000*** | ***5000- 15000*** | ***Slightly toxic*** |
| **Relatively harmless** | More than 15000 | > 15000 | Practically non-toxic |
| ***(Loomis et al.,1996)*** | | **(Pascoe et al., 1983)** | |

Similarly, according to OECD TG 423, OECD 425 any substance whose $LD_{50}$ value is above 5000mg/kg is considered to be ***practically non-toxic.*** Based on our finding and in comparison to the above classifications, crude powders and leaves ethanolic extracts of *P. juliflora* can be considered to be:

(i) Slightly toxic according to Pascoe *et al.,* 1983.
(ii) Practically non-toxic according to Loomis *et al.,* 1996 and OECD TG 423/OECD 425.
(iii) Unclassified according to GHS.

In general, its $LD_{50}$ values greater than 5000mg/kg which classify the plant as slightly toxic. This is in agreement

 

with the traditional usage by the Americans Indians who uses the pods to supplement their beverages and in treatment of skin ailments.

## Conclusions

Spectrometric detection of saponins, tannins, alkaloids in *P.juliflora* powders and from their extracts was performed directly using FTIR spectroscopy. The method is versatile, fast, and economical. *Prosopis juliflora* has an $LD_{50}$ values greater than 5000mg/kg and can be used by both human and animals, with a degree of safety and tolerance.

## Acknowledgements

This research was funded by the Research Production and Extension (RPE) division, Jomo Kenyatta University of Agriculture and Technology, and is highly appreciated. Thanks to Mr. Wambugu, Mr. Kung'u and Ms. Waithira for recording FTIR spectra.

## Result Tables

**Table 1**: Phytochemical test results in selected plant parts.

| **Plant part** | **Saponins** | **Tannins** | **Alkaloids** |
|---|---|---|---|
| **Leaves** | | | |
| Ethanolic extract | + | + | ++ |
| Aqueous extract | + | + | ++ |
| **Pods** | | | |
| Ethanolic extract | + | ++ | ++ |
| Aqueous extract | + | ++ | ++ |
| **Roots barks** | | | |
| Ethanolic extract | ++ | + | ++ |
| Aqueous extract | ++ | + | ++ |
| **Stem barks** | | | |
| Ethanolic extract | ++ | ++ | ++ |
| Aqueous extract | ++ | ++ | ++ |

**Table 2**: FTIR spectra of plant powders (KBr disc), $cm^{-1}$

| | **Plant samples and wave numbers ($cm^{-1}$)** | | | |
|---|---|---|---|---|
| **Functional group** | Root powder | Stem powder | Leaves powder | Pods powder |
| **O-$H_{str}$** | 3418 | 3422 | 3337 | 3352 |
| **N-$H_{str}$** | * | 2149 | * | * |
| **C-$H_{str}$** | 2928, 2368 | 2928, 2388 | 2924, 2866, 2365 | 2932 |
| **C=$C_{str}$** | 1624 | 1628 | 1643 | 1643 |
| **C=C-$C_{str}$ Aromatic** | 1524 | 1524 | 1555 | 1551 |
| **C-$O_{str}$ aromatic** | 1369 | 1331 | 1323 | * |
| **C-O-C)** | 1042 | 1045 | 1049 | 1057 |

*Not observed

**Table 3**: FTIR spectra of ethanolic extracts and leaves ethanolic extract (LEE) fractions (KBr disc), $cm^{-1}$

| | **Plant samples and wave numbers ($cm^{-1}$)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional group** | **REE** | **SEE** | **LEE** | **PEE** | **$F^A$** | **$F^B$** | **$F^C$** | **$F^D$** |
| **O-$H_{str}$** | 3248 | 3236, 3159 | 3398 | 3395 | 3387 | 3387 | 3472, 3345 3260, 3190 | 3209 |
| **N-$H_{str}$** | 2095 | * | * | * | * | * | 3140 3044 | 2168 |
| **C-$H_{str}$** | 2923, 2228, | 2928, 2870 | 2928,2862 , 2322 | 2928, 2866 | 2928,2862, 2322 | 2932,2866, 2318 | 2932 | 2939, 2326 |
| **C=$C_{str}$** | 1616 | 1616 | 1639 | 1639 | * | * | 1643 | 1632 |
| **C=C-$C_{str}$ Aromatic** | 1520, 1447 | 1520, 1447 | 1535, 1404 | 1531, 1447 | 1531, 1450 | 1524, 1447 | 1408 | 1408 |
| **C-$O_{str}$ aromatic** | 1366 | 1362, 1269 | 1246 | 1265 | 1373,1246, 1184 | 1385, 1246 | 1254 | 1234 |
| **C-O-C)** | 1053 | 1057 | 1069 | 1065 | 1092 | 1076 | 1069 | 1061 |
| **C=O** | * | * | * | 1717 | 1724 | 1701 | * | * |

Key: REE- root ethanolic extract; SEE-stem ethanolic extract; LEE- leaves ethanolic extract; PEE-pods ethanolic extract; $F^A$-LEE fraction 1; $F^B$-LEE fraction 2; $F^C$-LEE fraction 3; $F^d$-LEE fraction 4.

 

**Table: 4.Acute toxicity study of *P. juliflora* LEE after oral administration to rats**

| Dose (mg/kg) body weight | Sex | | | | Total number of rats used |
|---|---|---|---|---|---|
| | Male | | Female | | |
| | O (survived) | X (died) | O(survived) | X (died) | |
| **175** | 1 | 0 | 1 | 0 | 2 |
| **550** | 1 | 0 | 1 | 0 | 2 |
| **1750** | 2 | 1 | 2 | 1 | 6 |
| **2000** | 3 | 0 | 3 | 0 | 6 |
| **5000** | 3 | 0 | 3 | 0 | 6 |

**References**

Ahmad, A., Khursheed, A.K., Sabiha, Q. and Viqaruddin, A.B. (1989a). Antifungal activity of some hydrosoluble Prosopis juliflora alkaloids. Fitoterapia ,60:86 – 89.

Anonymous, (2003). Forestry Compendium. *CAB International Wallingford, UK.*

Bressani, R. (1977). "Protein supplementation and complementation," In: *Evaluation of proteins for humans,* ed. by The Avi Publishing Company Inc., Westport, Connecticut

Coates J. (2000). Interpretation of Infrared Spectra, A Practical Approach Encyclopedia of Analytical Chemistry. R.A. Meyers (Ed.) pp. 10815–10837: John Wiley & Sons Ltd, Chichester, 2000

Davidow, J. (1999). Infusions of Healing: A Treasury of Mexican-American Herbal Remedies. Simon and Schuster Inc. Desert USA. 13 June 2001

Daetwyler, P., Ott-Longoni, R., Schö pp, E. and Hesse, M. (1981). Over juliprosine, a further alkaloid from Prosopis juliflora A. DC. Helvetica Chimica Acta, 64: 1959-63.

Ebenshade, H.W. and Grainger, A. (1980). The Bamburi reclamation project. *International Tree Crops Journal*, pp: 199-202.

FAO , (1992). Fuelwood/ Afforestation and Extension in Baringo–Phase II, Kenya. Project findings and recommendations. FAO/Government cooperative program. FO:GCP/KEN/051/AUL.

Felker, P. and Bandurski, R.S. (1979). Uses and potential uses of leguminous trees for minimal energy input agriculture. Econ. Bot. pp:172–184.

Horbone J. B., (1973). Phytochemical methods: A Guide to modern techniques of plant analysis, Chapman and Hall, London, pp 279.

Kareru P.G., Kenji G. M., Gachanja A. N., Keriko J. M., Mungai G., (2007). Traditional Medicines and Healing Methods among Embu and Mbeere Peoples of Kenya: Afr. J. Trad. CAM., 4(1): 75-86.

Kariuki, P.M. (1993). A social forestry project in Baringo, Kenya: A critical analysis. Master of agricultural studies in rural development administration and management thesis. pp. 41-61. Kirmizigul S., Anil H., (2002). New Triterpenic saponins from *Celphalaria transsylvanica:* Turk J. Chem.: 26: 947-954.

Lenacuru, C. I. (2003). Impacts of *Prosopis* species in Baringo District. *Proceedings of workshop on integrated management of* Prosopis *species in Kenya*, pp. 41-47.

Loomis, T. A. and Hayes, A.W. (1996). Loomis's essentials of toxicology. 4th ed., California, Academic press: 208- 245

Maghembe, J.A., Kariuki, E.M. and Haller, R.D. (1983). Biomass and nutrient accumulation in young *Prosopis juliflora* at Mombasa, Kenya. *Agroforestry Systems*, 1:313-321.

Makkar, H.P.S., Bluemmel, M., Borowy, N.K. and Becker, K. (1993). Gravimetric determination of tannins and their correlations with chemical and protein precipitation methods. *Journal* of the *Science* of *Food* and *Agriculture,* 61: 161–165

Martin, R.S. and Briones, R. (1999). Industrial uses and sustainable supply of *Quillaja saponaria* (Rosaceae) saponins. *Economic Botany,* 53*:* 302–311. Pascoe, D. (1983). Toxicology. England, London, Edward Arnold limited.1-60.

Pasiecznik, N.M., Harris, P.C. and Smith, S.J. (2004). *Identifying Tropical Prosopis Species: A Field Guide*. HDRA, Coventry, UK. 31pp.

Pasiecznik, N., Felker P., Harris P., Harsh L., Cruz G., Tewari J., Cadoret K. and Maldonado L. (2001). The *Prosopis juliflora-Prosopis pallida* complex: A monograph. HDRA, Coventy, UK. pp.172.

Simpson, B.B. (ed.). (1977). Mesquite, its biology in two desert scrub ecosystems. Dowden, Hutchinson and Ross, Inc. Stroudsburg, PA.

Sofowora, A. ( 1993). Medicinal plants and Traditional Medicine in Africa. Spectrum Books, Ibadan, pp 150.

Tapia, A., Feresin, G.E., Bustos, D., Astudillo, L., Theoduloz, C. and Hirschmann, G.S. (2000). Biologically active alkaloids and a free radical scavenger from *Prosopis* species. *Journal of Ethnopharmacology*, 71 (1-2): 241-246.

Trease, G.E. and Evans, W.C. (1989). Pharmacognosy. 13th edn. Bailliere Tindall, London, pp 176-180.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

## CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

**Prospective authors of journals can find the submission instruction on the following page:** http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

## MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

## IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar