Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.12, 2015

Response of Growing Rabbits to Concentrate Diet Supplemented with Leucaena (Leucaena leucocephala) or Siratro (Macroptilium atropurpureum)Leaves

Makinde, O. J[1] Ibe, E.A[2] Ajibade, A.J[1]
1.Department of Animal Production Technology, Federal College of Wildlife Management, PMB 268, New Bussa, Niger State, Nigeria
2.Department of Agricultural Technology, Akanu Ibiam Federal Polytechnic, P.M.B. 1007, Unwana, Afikpo. Nigeria

Abstract
Thirty (30) 8-week old rabbits of average initial weight of 900 g were used to determine the Growth Performance and Carcass yield of growing rabbits fed Concentrate diet supplemented with ***Leucaena (****Leucaena leucocephala)*or Siratro (*Macroptilium atropurpureum*) leaves. The experiment was in a completely randomized design (CRD) with 5 treatment diets replicated thrice. The control group (T1) was fed a formulated rabbit diet, in T2, 10 % of the formulated rabbit feed was replaced with Leucaena fresh leaves, in T3, 20 % of the formulated rabbit feed was replaced with Leucaena fresh leaves, in T4, 10% of the formulated rabbit feed was replaced with Siratro fresh leaves and in T5, 20% of the formulated rabbit feed was replaced with Siratro fresh leaves. The study lasted 56 days. Feed and water were supplied *ad libitum*. Performance data indicated that body weight gain and feed conversion ratio were significantly ($P<0.05$) better in rabbits fed on 10% leucaena and 10% siratro inclusion than those fed on the 20% leucaena and 20% siratro inclusion levels. There were significant ($P<0.05$) differences in the organ weights of the rabbits except for lung and spleen ($P>0.05$). The weights of liver, heart and kidney were significantly ($P<0.05$) higher for rabbits fed 20%leucaena and 20%siratro diets than those fed other diets. From the results, it was concluded that inclusion of 10% leucaena or 10%siratro leaves in rabbits' diet has no adverse effects on the performance and carcass yield of growing rabbits.
Keywords: L***eucaena***, Performance, Siratro, Rabbits, Carcass yield.

INTRODUCTION

Rabbits have been recognized to have a very important role to play in the supply of animal protein to Nigerians especially in the rural and peri-urban areas. They are efficient converters of feed to meat and can utilize up to 30% crude fibre as against 10% by most poultry species. To make rabbit rearing more viable as a small-scale business, Makinde *et al*. (2014) have advocated the development of alternative feeding materials that will be relatively cheap when compared with commercial feeds or conventional feedstuffs. Rabbits have the potential of utilizing such unconventional feedstuffs as *mucuna utilis* leaf meal (Sese *et al*., 2014), neem leaf meal (Ogbuewu *et al*., 2008), pigeon pea seeds (Amaefule *et al*., 2005) and other diverse plant materials.

In several separate studies which involvedfeeding trials, leaf meals from *Aspilia africana and Tridax procumbens* (Ojebiyi *et al*., 2013), *Leucaena leucocephala* (Lamidi and Akilapa, 2013), *Balanites aegyptiaca* (Saleh *et al*., 2014) were reported to supply nutrients and improve the performance of rabbits. Similarly, leaf meals from *Centrosema*, *Manihot*, *Tithonia*, *Gmelina arborea* and *M. Puberula* have been reported to supply nutrients and improve the performance of pigs (Obua *et al*., 2013).

Like most legumes, *Leucaena leucocephala* (Leucaena) and *Macroptilium atropurpureum (Siratro)* are deep rooted legumes which have their origin in Mexico and Jamaica respectively, but have become naturalized in Nigeria (Babayemi *et al*., 2006). They thrive throughout the year and readily come to mind as an unconventional protein source with lots of potentials to be exploited in rabbit feeding. Leucaena leaves, flower, seeds and shoots are good sources of nutrients for livestock. Young leaves of leucaena contain more protein than the mature ones. Otesile and Akapokodje (1987) indicate that in spite of the nutritive potential of *Leucaena leucocephala*, its use by cattle as feed may result in certain undesirable effects. *Leucaena* levels should not exceed 30% for ruminants, 20% for rabbits, and 7.5% for poultry on a dry matter basis (Barry, 1987). There is paucity of information on the Utilization of *Macroptilium atropurpureum by livestock. Muir and Massaete* (1995) *evaluated the reproductive performance of rabbits fed wheat bran with tropical forages or Leucaena leucocephala*. The authors reported that *Leucaena leucocephala* was superior to other forages studied including *Macroptilium atropurpureum.*

The anti-nutritional factors (ANFs) present in these legumes such as mimosine, tannin, phytin, oxalate, saponin e.t.c has limited the percentage that can be included in the diet. Although, some animals have built resistance with microorganisms that can degrade these ANFs and its product, information is still needed regarding the potentialof these legumes as a feed for growing rabbits. Therefore,the current study was undertaken to determine the nutritional worth of Leucaena and Siratro leaves as a feed supplement for growing

rabbits.

MATERIALS AND METHODS

Animals and housing

The study was conducted with thirty(30) 8-week old hybrid (New Zealand white x Chinchilla) rabbits that had initial live weight ranging from 910 to 920 g. They were of both sexes and randomly assigned to 5 treatment diets in a completely randomized design (CRD). Each treatment was replicated 3 times with each replicate having 2 (male and female) rabbits.

The rabbits were housed in a 3-tier rabbit cage, which had a total of 15 hutches at 5 hutches per tier. The cage was located inside a building equipped with vents and windows for ventilation. Each hutch (100 cm x 40 cm x 40 cm), which accommodated the 2 rabbits, was partitioned with a wooden board and wire mesh and fitted with aluminum drinkers, feeders (15 cm x 10 cm x 10 cm) and an aluminum tray for collection of faeces.

Diets

Fresh forages (succulent stems and leaves) of *Leucaena leucocephala* and *Macroptilium atropurpureum* were harvested from the surroundings of the Rabbitry unit within the College community where they grew as weeds. They were cleaned of sands and other contaminants and fed with normal concentrate diets. The concentrate diet was formulated to contain 16% crude protein and 2540 kcal/kg metabolizable energy as shown in Table 1. Five dietary treatments consisting of forage and concentrate were fed in the following orders and designated as T1(Control diet), T2, T3, T4 and T5 respectively.

The control group (T1) was fed a formulated rabbit diet, in the second group (T2), 10 % of the formulated rabbit feed was replaced with Leucaena fresh leaves, in the third group (T3), 20 % of the formulated rabbit feed was replaced with Leucaena fresh leaves, in the fourth group (T4), 10% of the formulated rabbit feed was replaced with Siratro fresh leaves and in the fifth group (T5), 20% of the formulated rabbit feed was replaced with Siratro fresh leaves. The rabbits were fed daily for 56 days. Proximate composition of experimental diet and forages is given in Tables 1 and 2 respectively.

Table 1: Percentage composition of Concentrate diet

Ingredients	**%**
White maize	70.0
Local fish meal	1.0
Soybean meal	14.0
Palm kernel meal	12.0
Bone meal	2.50
Vitamin premix*	0.25
Salt	0.25
Total %	**100**
Calculated nutrients	
Crude Protein %	16.0
Crude Fibre %	3.76
ME (Kcal/kg)	2540.9
Avail. Ca %	0.99
Avail. P %	0.41

Table 2: Proximate composition of the Concentrate and Forage diets

Nutrients, % DM	**Concetrate**	**Leucaena**	**Siratro**
Dry Matter	87.50	91.26	90.38
Crude protein	15.75	17.76	18.72
Crude fiber	4.75	11.42	11.41
Ash	14.90	11.21	10.30
Ether extract	6.35	4.21	3.16
Nitrogen free extract	45.81	41.05	42.09

Data Collection

The study lasted for 8 weeks (56 days) during which the rabbits were fed the concentrate and forage diets *ad libitum*. The rabbits were weighed at the start of the experiment and subsequently on a weekly basis. Parameters measured were weight gain and feed intake. Feed conversion ratio (FCR) was calculated as using the formula= feed intake/ weight gain.

Carcass and Organs Evaluation

One rabbit from each replicate was selected, weighed, starved overnight to clear the gut and stunned. The rabbits were slaughtered by cutting the jugular vein with a sharp knife. The tail close to the base was first removed, and then the head, feet and pelt. During evisceration, the internal organs and other gut contents were removed and weighed. Then the dressed carcass was weighed and expressed as percentage of the live weight. The organ weights were expressed as percentage of the dressed weight.

Chemical and Data Analyses

Both Concentrate and Forages were analyzed for proximate composition using the methods of AOAC (2002). All data collected were subjected to analysis of variance (SAS, 2008). Differences between the treatment means were separated using Duncan's New Multiple Range Test at 5% level of significance.

RESULTS

Table 2 shows the proximate composition of the Concentrate and forage diets. The dry matter, crude protein, crude fiber, ash, ether extract and the nitrogen free extract respectively were 87.50, 15.75, 4.75, 14.90, 6.35 and 45.81% for Concetrate diet. Leucaena leaves contained dry matter of 91.26%, crude protein of 17.76%, crude fiber of 11.42%, ash of 11.21%, ether extract of 4.21% and nitrogen free extract of 41.05% while the Siratro leaves contained 90.38%, 18.72%, 11.41%, 10.30%, 3.16% and 42.09% for dry matter, crude protein, crude fiber, ash, ether extract and the nitrogen free extract respectively.

The growth performance of the growing rabbits fed the experimental diets is shown in Table 3. The rabbits had similar body weights at the start of the experiment. Average body weight and average feed intake of rabbits fed the control, 10% leucaena and 10% siratro diets were significantly (P<0.05) higher than for rabbits fed 20% leucaena and 20% siratro diets. Feed conversion ratio was significantly (P<0.05) better for rabbits fed 10% leucaena and 10% siratro diets than those fed other diets. Rabbits fed 20% leucaena and 20% siratro had poorer weight gain (7.81, 8.40g), poorer feed intake (49.42, 47.58g) and poorer FCR (6.33, 5.66).

Table 3: Growth performance traits of growing rabbits fed concentrate and forage diets

Parameters	T1	T2	T3	T4	T5	SEM
Initial weight, g	918.19	916.02	921.43	915.67	920.81	4.40 ^{ns}
Final weight, g	1532.06^{a}	1665.22^{a}	1358.51^{b}	1579.32^{a}	1391.43^{b}	68.71*
Total weight gain, g	613.87^{a}	749.22^{a}	437.08^{b}	663.65^{a}	470.62^{b}	57.33*
Av. daily weight gain, g/d	10.96^{a}	13.38^{a}	7.81^{b}	11.85^{a}	8.40^{b}	1.51*
Total feed intake, g	3185.51^{a}	3068.22^{a}	2767.43^{b}	3100.09^{a}	2664.46^{b}	65.78*
Av. daily feed intake, g/d	56.88^{a}	54.79^{a}	49.42^{b}	55.36^{a}	47.58^{b}	1.17*
Feed conversion ratio	5.19^{b}	4.09^{a}	6.33^{b}	4.67^{a}	5.66^{b}	0.40*
Mortality	0	0	1	0	1	-

SEM=Standard error of mean.* = P<0.05, ns = Not significant

Table 4 shows the effect of dietary treatments on the dressed carcass and organ percentage of the rabbits.There were significant (P<0.05) differences in the organs weights of the rabbits except for lung and spleen. The weights of liver, heart and kidney were significantly (P<0.05) higher for rabbits fed 20%leucaena and 20%siratro diets than those fed other diets. However, the weight of lungs and spleen were not influenced (P>0.05) by the dietary treatments.

Table 4: Dressed Carcass and Organ Percentage of growing rabbits fed Concentrate and Forage diets

Parameters	T1	T2	T3	T4	T5	SEM
Dressed carcass, %	65.95^{a}	66.90^{a}	60.10^{b}	66.16^{a}	59.98^{b}	0.43*
Liver, %	3.05^{b}	3.44^{b}	4.64^{a}	3.55^{b}	4.49^{a}	0.48*
Heart, %	0.33^{b}	0.40^{a}	0.32^{b}	0.38^{a}	0.30^{b}	0.02^{ns}
Kidney, %	0.60^{b}	0.70^{b}	0.87^{a}	0.71^{b}	0.85^{a}	0.10*
Lung, %	0.61	0.62	0.59	0.64	0.60	0.04^{ns}
Spleen, %	0.04	0.05	0.04	0.05	0.02	0.02^{ns}

SEM = Standard error of mean. * = P<0.05, ns = Not significant

DISCUSSION

Legumes are rich sources of nutrients especially amino acids and minerals. Several researches have been carried out on the utilization of legume seed meal and leaves as feed for livestock with positive results on performance (Sese *et al*., 2014; Ogbuewu *et al*., 2008; Amaefule *et al*., 2005). The current study was undertaken todetermine the potential of Leucaena and Siratro leaves as a feed supplement in growing rabbits. The growth performance parameters were generally in agreement with those observed in the previous studies (Ogbuewu *et al*., 2008; Amaefule *et al*., 2005). Body weight gain per day and daily feed intake were enhanced by supplementing the feed with 10 % Leucaena and 10% Siratro leaves (T2 and T4). However, the parameters were significantly

reduced in rabbits fed with diets supplementedwith 20 % Leucaena and 20% Siratro leaves. This significant decline in weight gain and feed intake at 20 %dietary inclusion of Leucaena and Siratro leaves could be attributed tothe presence of some anti-nutritional factors (ANF),which are thought to be prevalent in most raw legumes (D'Mello, 1982). Previous studies have indicated that the presence of some antinutritional factors like tannins in the diets results in poor palatability and consequent decrease in feed intake due to its astringent property as a result of its ability to bind with protein of saliva and mucous membrane (Makinde *et al*., 2014). Also, phytic acid is widely distributed in commonly consumed foods and found in almost all feeds of plant origin. Phytic acid as powerful chelating agent reduces the bioavailability of divalent cations by the formation of insoluble complexes which are mostly not available to monogastrics (Weaver and Kanna, 2002). In consequence, the consumption of feed containing high phytin content could produce a deficit in the absorption of some dietary minerals and can also adversely affect the digestibility of protein by inhibiting a number of digestive enzymes in the gastro-intestinal tract such as pepsin, trypsin and chymotrypsin (Cadwell, 1992). Furthermore, (Mtenga and Laswai, 1994) reported that when rabbits feed on 30% of leucaena leaf blended meal, there were low growth rate and feed utilisation was inefficient. At 20% of leucaena blended meal, rabbits experience severe alopecia. Mortality was generally low across the treatment groups with one death occurring in T3 and T5 while T1, T2 and T4 recorded none. This invariably confirms that the effect of anti-nutritional factors in diets 1, 2 and 4 were within tolerable limit.The result of this study further validates the assertion of Lamidi and Akilapa (2014) who recommended that for good performance of rabbits, doe or buck, 10% leucaena leaves should be blended with their feed.

There were significant ($P<0.05$) differences in the organs weights of the rabbits except for lung and spleen. It is a common practice in feeding trials to use weights of some internal organs like the liver or kidneys as indicators of toxicity because they should differ significantly if there was any serious effect of antinutritional factors on them being major detoxification organs (Sese and Berepubo, 1996). The difference in weight would arise because of increased metabolic rate of the organs in attempt to reduce toxic elements or anti-nutritional factors to non-toxic metabolites (Bone, 1979). It was obvious in this study that the weight of organs such as liver, heart and kidney were significantly ($P<0.05$) higher in rabbits fed 20% leucaena and 20% siratro leaves as a result of increased metabolic rate. This observation agrees with the report of Fayemi *et al*., (2011) who observed that rabbits fed diets containing 20% Sun dried *Leucaena leucocephala* leaves had alopecia, necrotic spots, liver congestion, edema and highest percentage mortality. These workers also reported that diets containing more than 1% of mimosine and tannin impaired the growth performance and had deleterious effects on the liver of rabbits. Manoji and Samiran (2007) indicated that inspite of being an excellent source of nutrients *Leucaena leucocephala* forage as well as seed contains a number of toxic constituents which severely limit livestock performance. They further found out that tannin concentrations are higher in leaf meal than in seed and that these toxins reduce digestibility of proteins and results in marked low metabolizable value of Leucaena leaf meal in poultry. The values reported for the various organs in this study however conforms with those reported for rabbits fed *Mucuna utilis* leaf meal (Sese *et al*., 2014), rabbits fed boiled pigeon pea seed meal (Amaefule *et al*., 2005) and rabbits fed concentrates, *Aspilia africana and Tridax procumbens* (Ojebiyi *et al.*, 2013).

CONCLUSION

This study determines the Growth Performance and Carcass yield of growing rabbits fed Concentrate diet supplemented with ***Leucaena (****Leucaena leucocephala)* or Siratro (*Macroptilium atropurpureum*) leaves. It was observed that the inclusion of leucaena and siratro leaves beyond 10% in rabbit's diet leads to poor feed intake and feed conversion ratio as the average body weight gain and final weight gain also decreased with diets at 20% levels. The poor performance of rabbits fed 20% level of inclusion could be due to the amount of anti-nutritional factor present at that level. Carcass yield of rabbits were influenced ($P<0.05$) by the dietary treatments. From the results, it was concluded that inclusion of 10% leucaena or 10% siratro leaves in rabbits' diet has no adverse effects on the growth performance and carcass yield of growing rabbits.

REFERENCES

Ahamefule, F.O., Obua, B.E., Ukweni. I.A., Oguike, M.A. and Amaka, R.A. (2008). Haematological and biochemical profile of weaner rabbits fed raw or processed pigeon pea seed meal based diets. *African Journal of Agricultural Research,* 3(4): 315-319.

Amaefule, K.U., Iheukwumere, F.C. and Nwaokoro, C.C. (2005). A note on the growth performance and carcass characteristics of rabbits fed graded dietary levels of boiled pigeon pea seed (*Cajanus cajan)*. *Livestock Research for Rural Development*. 17(5).

AOAC., (2002). Official Methods of Analysis of Official Chemists. 17th Ed, Association of Analytical Chemists, Washington DC, USA.

Babayemi, O.J., Ajayi, F.T., Taiwo, A.A., Bamikole, M.A. and Fajimi, A.K. (2006). Performance of West African dwarf goats fed *Panicum maximum* and concentrate diets supplemented with Lablab (*Lablab*

purpureus), Leucaena (*Leucaena leucocephala*) and Gliricidia (*Gliricidia sepium*) foliage, www.feedipedia.org/node/2660, *Nigerian J. Anim. Prod.*, 33 (1&2): 102-111.

Barger, A.M. (2003). The complete blood cell count: Apowerful diagnostic tool. Vet. Clin. *North America Small Anim. Pract*., 33: 1207-1222.

Barry, T.N.(1987). The Nutrition of Herbivores (Ed.) London: Academic Press U.K.

Bone, F.J.(1979). Anatomy and Physiology of farm Animals. 2nd Ed. Reston Publishing Company, Inc Virginia, USA, pp.560.

Cadwell, R.A.(1992). Effects of calcium and phytic acid on the activation of trysinogen and stability of trypsin. *J. Agr. Food Chem.*, 40: 43-48.

D'Mello, J.P.F.(1982). Toxic factors in some tropical legumes. *World Rev. Anim. Prod*. 4: 41-46.

Fayemi, P.O., Onwuka, C.F.I., Isah, O.A., Jegede, A.V., Arigbede, O.M. and Muchenje, V.(2011). "Effects of Mimosine and tannin toxicity on rabbits fed processed *Leucaena leucocephala* (Lam) Leaves." *African Journal of Agricultural Research*. 6(3): 251-259.

Frederick, N.(2010). Effect of MoringaLeaf Meal (MOLM) on Nutrient digestibility, Growth, Carcass and Blood indices of Weaner Rabbits. Msc thesis.Kwame Nkrumah University of Science and Technology, Kumasi. pp 87.

Fudge, C.S. (1999). Laboratory Medicine: Avian and Exotic Pets. WB Saunders, Philadelphia, USA.

Hillyer, E.V.(1994). Rabbits. *Small Anim Pract.*, 24: 25-65.

Lamidi, W.A. and Akilapa, T.P.(2013). Performance Characteristics of Rabbits fed with Leucaena leaf meal based diet in Natural Housing System. *Agricultural Science Research Journal.* 3(5):144-151.

Makinde, O.J., Enyigwe, P.C., Babajide, S.E., Atsumbe, J.A., Ibe, E.A. and Samuel, I.(2014). Growth performance and carcass characteristics of Finisher broilers fed rice offal based diets supplemented with exogenous enzyme. *Greener Journal of Agricultural Sciences*. 4(4): 144 -149.

Manoji, K.G. and Samiran, B.(2007). "Mimosine toxicity-A problem of *Leucaena*feeding in Ruminants." *Asian Journal of Animal and Veterinary Advances.* 2: 63-73.

Mtenga, L.A. and Laswai, G.H. (1994). LeucaenaLeucocephala as feed for rabbits and pigs: detailed chemical compositional and effect of level of inclusion on performance. *Ecology Management Journal*. 54: 249-257.

Muir, J.P. and Massaete, E.S.(1995). Reproductive Performance of Rabbits fed Wheat bran with Tropical forages or Leucaena leucocephala. World Rabbit Sci. 3(2): 91-93.

Njidda, A.A. and Isidahomen, C.E. (2011). Hematological parameters and carcasscharacteristics of weanling rabbits fed sesame seedmeal (*Sesamum indicum*) in a semi-arid region. *Pak. Vet. J.* 31(1): 35-39.

Obua, B.E., McAlbert, F.U., Okoro, B.O. and Efrenie, S.(2012). Survey of the diversity of forage Plants used in feeding Pigs in smallholder farms in Southeastern Nigeria. *Int'l Journal of Agric. and Rural Dev.*15 (3):1310-1316.

Ogbuewu, I.P., Okoli, I.C. and Lioeje, M.U.(2008). Serum Biochemical Evaluation and Organ Weight Characteristics of Buck Rabbits Fed Graded Levels of Neem (*Azadirachta Indica*) Leaf Meals Diets. http://neem rabbits.htm.Accessed on 08/06/2008.

Ojebiyi, O.O., Shittu, M.D., Oladunjoye, I.O., Omotola, O.B. and Olaniyi, S.A.(2013). Haematology, Carcass and Relative Organ Weights of Growing Rabbits on Skip-A-Day Concentrate Feeding Regime. *IJAAAR.*, 9(1&2): 167-174.

Onifade, A.A. and Tewe, O.O.(1993). Alternative tropical energy feed resources in rabbits diets:growth performance, diets digestibility and blood composition. *World Rabbits Sci*. 23:141-142.

Otesile, E.B. and Akapokodje, J.U. (1987). *Leucaena leucocephala* toxicity in N'dama cattles. *Bulletin of Animal Health Production in* Africa. 35: 77 – 78.

S.A.S.(2008). User's guide: Statistics. Version 12.0.SAS Institute, Inc. Cary. NC, USA. 2008.

Saleh, J.L., Njidda, A.A., Adeniji, A.A. and Lawan, G.B.(2014). Haematological and Biochemical Indices of Rabbits FedGraded Levels Browse Forage (*Balanites aegyptiaca*) in SemiArid Environment. *Global Journal of science Frontier Research:DAgriculture and Veterinay.* 14(2):43-48, 2014.

Sese, B.T. and Berepubo, N.A.(1996). Growth response and organ weight of young rabbits fed graded levels of dietary soybean in the hot humid tropics. *World Rabbit Sci*. 4(1): 15-18, 1996.

Sese, B.T., Okpeku, M. and Igirigi, A.(2014). Impact of Tropical Velvet Bean (*Mucuna Utilis*) Leaf Meal on Performance, Organ Weight and Haematological Indices of Young Rabbits.*J. Anim. Sci. Adv.* 4(4): 777-786, 2014.

Weaver, C.M. and Kanna, S.(2002). Phytate and mineral bioavailability In: Reddy, N.R. and Sathe, S.K., editors food phytates. CRC press bocaraton. Pp. 211-224.

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