Fuzzy Approach for Load Balancing in Computer Networks

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Abstract

In computer networks, load balancing problem is very necessary. Imbalance load of traffic among nodes (or links) reduces the performance of the networks. In this paper, a system based on fuzzy logic is proposed for solving the load balancing problem in the computer networks. The fuzzy system located at each node of the computer network to make a load balancing of links by using two criteria which are link capacity and traffic density. The proposed system are applied for typical examples of computer networks and for two types of data traffic (low and high). Results of this fuzzy system assert its high achievement.

طريقة مضببة لموازنة حمل في شبكات حاسبات

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المستخلص

في شبكات الحاسبات، موازنة الحمل مسألة ضرورية جدا". الحمل غير الموزون للبيانات المارة بين النقاط (او الروابط) يخفض انجازية الشبكات. في هذا البحث، اقترح نظام يستند على المنطق المضبب لحل مسألة موازنة الحمل في شبكات الحاسبات. النظام المضبب يقع في كل نقطة لشبكة الحاسبات ليصنع موازنة حمل للروابط بأستخدام قياسين هما قابلية الرابط وكثافة البيانات المارة. النظام المقترح طبق لأمثلة نموذجية لشبكات الحاسبات والى نوعين من البيانات المارة (واطئة وعالية). نتائج هذا النظام المضبب اكدت على انجازيته العالية.

1. Introduction

Computer networks can provide full capacity for transferring the data. Imbalance workloads among nodes (or links) reduce the performance of the networks. As the configurations of today's computer networks are becoming more complicated, achieving high performance is becoming more challenging. Load balancing is crucial, since it ensures a good use of the network capacity, for that algorithms have been devised to improve the performance of the networks. Distributed algorithms usually use local information for transferring excessive

loads in heavily loaded nodes to lightly loaded nodes. In conventional load balancing methods, fixed threshold levels are used to decide whether a node is heavily or lightly loaded [1, 2].

The increase in traffic volume on the computer networks leads to a higher frequency of overloaded links in the network, causing a decrease in performance. When link loads approach link capacities, the network becomes congested with resulting packet loss. Balancing the traffic becomes important in order to redirect traffic from congested links to less utilised links and achieve a more efficient utillisation of the network [3].

2. Fuzzy Logic

Fuzzy logic was initiated in 1965, by lotfi A. Zadeh, professor for computer science at the University of Californiа in Berkeley. Basically, Fuzzy logic is a multivalued logic, that allows itermediate values to be defined between conventional evaluations like (true/false, yes/no, high/low, …). Notions like rather tall or very fast can be formulated mathematically and processed by computers, in order to apply a more human-like way of thinking in the programming of computers [4].

Fuzzy interpretations of data structures are a very natural and intuitively way to formulate and solve various problems. Elements of a fuzzy set are taken from a universe of discourse. The universe contains all elements that can come into consideration. Every element in the universe is a member of the fuzzy set to some grade, maybe even zero. The set of elements that have a non-zero membership is called the support of the fuzzy set. The function that ties a number to each element of the universe is called the membership function [5, 6].

Fuzzy logic is a method of characterizing knowledge in terms of fuzzy sets and a rule base. A fuzzy system has one or more inputs that are fuzzified, a rule base that is evaluated according to the inputs, and one or more outputs that are defuzzifd into crisp values [7].

3. Load Balancing

In computer network, load balancing is a technique to spread work between two or more nodes (computers, printers, switching, …), links, CPUs, hard drives, or other resources, in order to get optimal resource utilization, throughput, or response time. Using multiple components with load balancing, instead of a single component, may increase reliability through redundancy. Load balancing attempts to maximize network throughput by keeping all nodes or links busy, it is done that by migrating tasks from the overloaded nodes to other lightly There are two methods of load balancing are used generally, that, static and dynamic. In static

method, threshod levels are fixed and are not changed according to the current status of the computer network. Therefore, nodes in the network do not exchange state information for choosing new threshold levels. While, in dynamic method, threshod levels are changed according to the current status of the network. State information exchange is necessary when this method is used. Then, dynamic load balancing algorithms can respond better to network changes and result in better performance. Furthermore, load balancing is commonly classified into two categories, mulipath and gateway. The traffic load of multipath between a source node and a destination node, while of gateway is distributed amang a set of alternative paths in order to maximize throughput performance and minimize the impact of route failure [1, 9, 10].

Subject of load balancing is the incoming network packet stream which is partitioned according to a division scheme. Division schemes exhibit static or dynamic properties. The static scheme matches a fixed criterion, whereas a dynamic scheme uses a varying criterion that depends on the incoming traffic. Also, division schemes can be stateful or stateless. A stateful scheme relies on stored information to decide to which node an incoming packet hat to be forwarded. Stateless division on the other hand does not accumulate any kind of state. Further, division schemes are classified as packet-based or flow-based. Packet-based approaches consider a single packet as unit to distribute, whereas flow-based schemes consider a connection as distribution unit [11].

Considerable research has been devoted toward solving the load balancing problem in the computer networks. A. Maji [12] proposes a few enhancements to existing algorithms to remove the unbalanced distribution of nodes under the cluster heads and increase the active life of a node in ad hoc network. M. Tekaya, N.Tabbane and S.Tabbane [13] present a new protocol to achieve better load balancing with respect to the end-to-end QoS requirement in ad hoc network. S. Nejad, S. Mortazavi and B. vahdat [14] propose an intelligent algorithm based on fuzzy logic for load balancing in the centralized distributed system. M. Shahverdy, M. Behnami and M. Fathy [15] propose an algorithm to detect bottleneck and remedies for load balancing in wireless mesh networks. S. Naaz, A. Alam and R. Biswas [16] implement the fuzzy load balancing algorithm and compared the effect of using different defuzzification methods, reported in the literature. A. Alakeel [17] proposes a new fuzzy dynamic load balancing algorithm for homogenous distributed systems. It dealing with inaccurate load information, making load distribution decisions, and maintaining overall system stability.

4. Proposed Method

A fuzzy system is designed for solving the load balancing problem in the computer networks. It has two input variables, they are link-capacity and traffic-density, and one output variable which is the load. This fuzzy system is located at each node of the computer network to make a load balancing of links by using two criteria which are link capacity and traffic density.

The linguistic values with trapezoidal or triangular membership functions of the fuzzy system variables are:

- (Zero, Small, Medium, Big) of link-capacity
- (Low, Medium, High, Very high) of traffic-density
- (Very lightly, Lightly, Medium, Heavey, Very heavey) of load.

Table (1) shows the rule base of fuzzy inference for this system and its membership functions are shown in Figure (1) (where μ is value of the membership function).

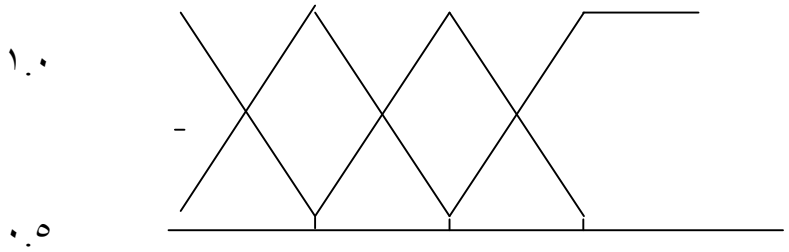
Table (1)
the rule base of the fuzzy system

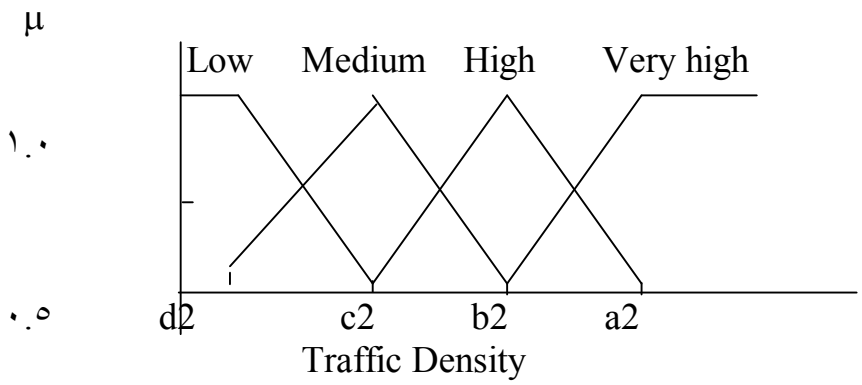
Link capacity / Traffic density	Zero	Small	Medium	Big
Low	Very heavey	Lightly	Very lightly	Very lightly
Medium	Very heavey	Medium	Medium	Lightly
High	Very heavey	Very heavey	Heavey	Medium
Very high	Very heavey	Very heavey	Very heavey	Heavey

For instance in Table (1), the load of link is Very lightly when the link capacity is Big and the traffic density is low. But, the load of link is Heavey when the link capacity is Big and the traffic density is very high.

μ

Zero Small Medium Big





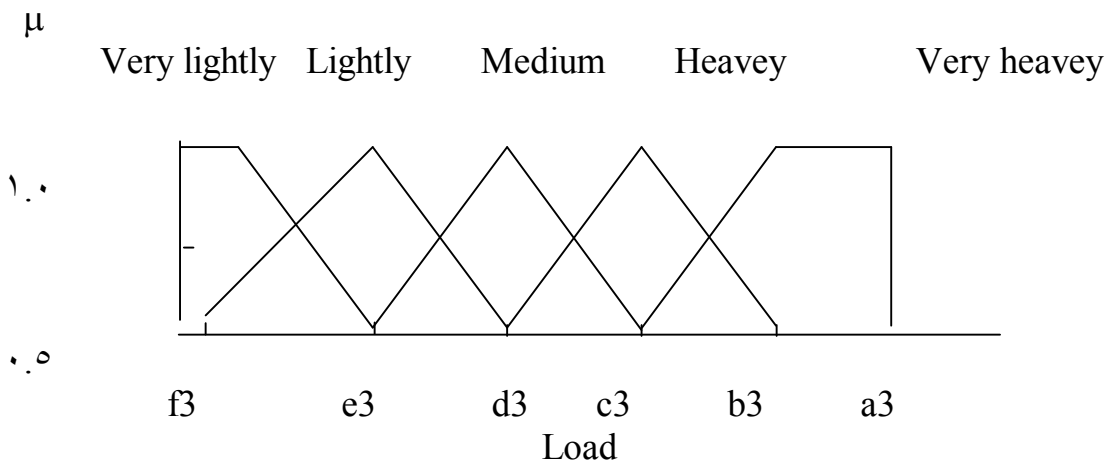


Figure (1) membership functions

5. Simulation Result

The simulation has been realized using C++ programming language, for evaluating the efficiency of the proposed method of using fuzzy system to solve the load balancing problem. Through that, it is applied for two examples of computer networks which are modeled as graphs, the first is a computer network (CN1) shown in Figur (2). While the second is a computer network (CN2) shown in Figure (3). The ranges of the membership functions of the fuzzy system are selected

to cover the two computer networks (CN1, CN2). The centers of the membership functions corresponding with two types of data traffic (low and high) as described in Table (2)-(4). The rule base of this fuzzy system is of Mamdani type. The Center of Gravity (CoG) method is used at defuzzification stage of the system. The crisp value of the output variable is the value of the center of gravity of the membership functions as given in the following equation.

$$\text{crisp value} = \sum_{i=1}^{n} c_i A_i \Big/ \sum_{i=1}^{n} A_i$$

where n is the number of activition rules, c_i is the center of membership function, A_i

is the area of activition part of membership function.

Some of the results of the fuzzy system for the computer networks (CN1,CN2) and for two types of data traffic (low and high) are listed in Tables (5)_ (6). In these Tables, the values of the inputs and outputs variables corresponding to the linguistic values of the membership functions of these variables are given in Figure (1).

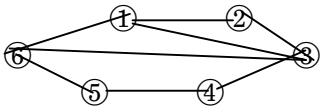


Figure (2) computer network (CN1)

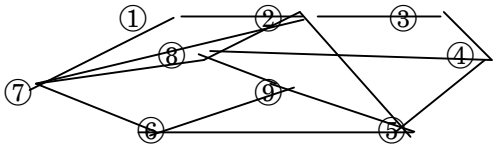


Figure (3) computer network (CN2)

Table (2)
centers of link capacity membership function

Centers	CN1		CN2	
	High traffic (Mbps)	**Low traffic (Kbps)**	**High traffic (Mbps)**	**Low traffic (Kbps)**
a1	0	10	0	100

Centers	CN1		CN2	
	High traffic (Mbps)	**Low traffic (Kbps)**	**High traffic (Mbps)**	**Low traffic (Kbps)**
b1	1	50	2.75	250
c1	2	90	5.5	400

Table (3)
centers of traffic density membership function

Centers	CN1		CN2	
	High traffic	Low traffic	High traffic	Low traffic
a2	**2**	**15**	**2**	**100**
b2	**2.75**	**95**	**6**	**400**
c2	**3.5**	**175**	**10**	**700**
d2	**4.25**	**255**	**14**	**1000**

Table (4)
centers of load membership function

Centers	CN1		CN2	
	High traffic	Low traffic	High traffic	Low traffic
a3	2	20	5	50
b3	6	60	15	150
c3	10	100	25	250
d3	14	140	35	350
e3	18	180	45	450
f3	22	220	55	550

Table (5)
results of the fuzzy system for the computer network (CN1)

Traffic type	Link capacity	Traffic density	Load
Low traffic	20	34	141.13
	80	200	164.339
	130	240	129.581
High traffic	0.5	3.75	18
	1.25	3	12.6707
	2.75	3.5	11.2727

Table (6)
results of the fuzzy system for the computer network (CN2)

Traffic type	Link capacity	Traffic density	Load
Low traffic	**150**	**350**	**351.351**
	500	**400**	**188.462**
	450	**750**	**337.838**
High traffic	**8**	**13**	**33.4673**
	7.5	**10**	**28.3728**
	0.2	**9**	**43.3065**

6. **Conclusions**

The proposed method which used fuzzy system to solve the load balancing problem of the computer networks is described in this paper. The fuzzy system at each node of network, to determine the load of links depending on two primary criteria that are link capacity and traffic density.

From the simulation results, the following points are noticed.

- The structure of proposed fuzzy system is not related to the size of the computer network.
- The input and the output of proposed fuzzy system are information about the one link of neighbor node in the computer network. The results show that the fuzzy system has good performance to find the load of links for both computer networks (CN1, CN2) . The load is compared of two types of data traffic (low and high) through these results.

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Evaluation antibacterial activity of compounds extracted from three Aspergillus species

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Abstract :

Three fungal species (A.niger A. terrus, and A .flavus) extracts were evaluated for their antibacterial activity by using Kirby Bauer diffusion test against Gram negative and Gram positive bacteria. All broth media of fungal species were extracted using ethyl acetate as organic solvent. Aspergillus niger extract showed a significantly antibacterial activity against Escherichia coli and staphylococcus aureus in compared with the ether fungal species, all the fungal species extract have the same chemical compounds represented by alkaloids, tannins, saponins and flavonoids.

Keywords: Evaluation , antibacterial activity, Extraction, Aspergillus species

Introduction :

Natural products are an important source of new bioactive compounds and for the drugs launched over the period 1981- 2002, (21) found that 40% were either natural products as is ,or modified natural products.

The search of new pharmacologically active agents obtained by screening natural source such as microbial fermentation and plant extracts had led to discovery of many clinically useful drugs that play a major role in the treatment of human disease . The extraction process is an important step in the investigation of biologically active compounds when extraction compounds from fungi or any living source the type of solvent used the extraction process employed and the age, part of cultivation of living tissue, can all have a marked effect on the type of compound that can be extracted (22).

Due to their Pharmaceutical potential secondary metabolites of fungi have been studied for more than 70 years. The search for new drugs from fungi started with the discovery of penicillin by Fleming in 1929 a potent antibiotic against

Gram positive bacteria which was produced by Penicillium notatum. A further millstone in the history of fungal products for medicinal use was the discovery of the immunosuppressant cyclosporine which is produced,e.g. by Tolypocladium inflatum and Cylindrocarpon lucidum (8).

- PhD in Medical Mycology
- PhD in Biotechnology
- MSc in Mycology

The antifungal agent griseofulvin being isolated from Pencillium griseoflavin and the cholesterol biosynthesis lavastain isolated from Aspergillus terreus are tow further examples supporting today's great interest in new secondary metabolites from fungi(٢).

Most fungi studied to date have been isolated from soil and proven to have a highly creativity index,i.e.new and interesting secondary metabolites could be isolated genera as Aspergillus, Pencillium, Acermonium, Fusarium, typical soil isolates, are known for their ability to synthesis divers chemical structure. The genus Aspergillus is known to elaborate a number of secondary metabolites, some of which posses antibiotic activity.(15) .Table(1) provides some of metabolites isolates from Aspergillus.

Table(1)
some antibiotic isolated from Aspergillus species

Fungus species	Metabolire(s) isolated	Literature citation
Aspergillus Panamensis	Tetronic acid derivatives	4
A.aculeatus	Aculracin A	13
A. terrus	Tetracycline acid A	19
A. versicolor	Mycoversillin	24
A. fumigatus	Fumi fungi	18
A. sydowii	Mulumdo candin	23
A.sydowii Var.muludensis	Deoxymuludo candin	17

Material and methods

- Isolation of fungal species

The producing organism were isolated (A.niger A. terrus, and A .flavus) from soil using dilution method described by (14).

- Culture media

All media prepared as described by their company manufacturer instrucion

- Fermentation

The culture of Aspergillus species were maintained on potato dextrose agar. The stock cultures were inoculated in 250 ml flasks containing 100ml of potato dextrose agar and incubated for 7 days at 27 C. Preparation of spore suspension

was performed by addition of 50 ml of sterilized distilled water to the 250ml flasks followed by vigorous of the water over the agar surface with a sterile loop, 2 ml of the spore suspension were used for the inoculation of a 2 liter conical flask each flask containing 1 liter of the following medium: g/100 ml glucose 1.0sucros 2.0gmNaNo30.2gmK_2HPO_4 0.1gmKCl 0.05gm$MgSO_4.7H_2O$ 0.05gm$FeSO_4.7H_2O$ 0.001gm corn step liquor 1.0gm .(PH adjusted to 6.0 prior to sterilization) The flask were incubated on a rotary shaker at 120 rpm at 27 C for 10 days for the production of organic materials.(25).

Isolation of compound

After 10 days old culture broth of each species of Aspergillus were filtered by whatman No.1 to separate mycelium. The both filtration of each species was adjusted to pH 3 with (1N HCl) and extracted with equal volume of ethyl acetate by separated funnel, the ethyl acetate layer was dried over Na_2SO_4 and concentrated in vacuum to dryness (organic matter). (26)

Antibacterial activity

The ethyl acetate extracte of three Aspergillus species were studied for anti bacterial activity against tow bacterial species E.coli and S.aureus by using Kirby Bauer diffusion test. Petri dishes with 20ml of Muller-Hinton agar were prepared , inoculated with 1*10^6 cell/ml. Sterile filter paper disc of 6mm in diameter were laoded with 150 ug/ml of each extracts using micro pipette and were dried under laminar air flow hood. The inoculated plates were inocubated for 24 hours at 37C. Standard antibiotic, Streptomycin, Erythromycin, Neomycin,Fusidic acid and Tetracycline were used as appositive control. After inocubation time, the diameter of inhibition zone diameter were measured in mm.(5)

Qualitative analysis of fungal extracts:

Preliminary qualitative analysis extracts were performed using the following tests:

1- **Carbohydrates test**. Carbohydrates were tested using Molish's reagent as follows: 1ml. of extract was mixed with 5 drops of alcoholic a-naphthol in test tube, with well shaking 2.5ml of sulfuric acid was added. Violet ring was formation, indicates the presence of carbohydrates.(11)

2- **Alkaloid test:**

Using meyer's reagent: it consists of:

Solution 1: 1.36gm. of mercury chloride ($HgCl_2$) dissolved into 60ml.distaled water

Solution 2 : 5gm. of potassium iodide dissolved in 10 ml.distaled water

Solution 1 mixed with solution 2 , 1ml. of extracts was added to 1 ml. of reagent, creamy precipitate indicates the presence alkaloid (10).

3- Flavnoid test:

1ml.of extract was mixed with 1ml. of alcoholic potassium hydroxide 0.5m. yellow precipitate indicate the presence of flavonoid (3)

4-Phenol's test

Ferric chloride test:

One gm. of ferric chloride dissolved in 100ml. D.W, then equal volume of extract and reagent 1:1 were mixed and blue or green color was formed. This indicates the presence of phenols.(6)

5- tannins test:

Ferric chloride test:

Five drops of 1% w/v ferric chloride in D.W were added into 1 ml. of extract, when blue- green color is formed this indicates the presence of tannins(7).

6- Saponin test:

1 ml. of extract was added to one ml. of (5%)$HgCl_2$ in D.W the formation of white precipitate indicates the presence of Saponins (9).

Statistical analysis :

Analysis of data used in this study dune by SSPS statistics 17.0

Result

Results showed that fungal species appear obvious significantly differences on their antibacterial activity against Gram negative and Gram positive bacteria. A.niger showed highly significant differences ($P<0.05$)in their antibacterial activity reach to 17 mm against E.coli followed by A.flavus 14mm A.terreus 9mm,while the fungus A.niger was showed significantly differences in their antibacterial activity on gram positive bacteria reach to 20mm followed by A.flavus 17.5mm and A.terreus 17mm, as in Table(2). while Table (3) showed antibacterial activity for some standard antibiotic activity presented by inhibition zone.

Table(2)
Antibacterial activity of Aspergillus species extracts

BACTRIA Bacteria Fungal Species extract	inhibition diameter mm	
	E.coil	S.aureus
A.flavus A.niger A.terreus	14 17 9	17 20 17

Qualitative Chemical Analysis of fungal extracts showed differences in their chemical compound in three aspergillus species A.flavus contains flavonoid, phenols,tannins and saponins without alkaloids where as the extract of A.niger

had alkaloids,flavonoids, saponins,where as the extract of A.terreus had all compounds without flavnoids.

Table(3)
preliminary Qualitative chemical Analysis of Bioactive extracts

Compounds	Test	A. flavus	A.niger	A.terreus	Indicator (+ve)
Carbohydrate	Molish reagent	+	-	+	Violet ring
Alkaloids	Meyer's reagent	-	+	+	Creamy precipitate
Flavonoids	Alchoholic OH	+	+	-	Yellow precipitate
Phenols	Ferric chloride	+	-	+	Blue or green color
Tannins	Ferric chloride	+	-	+	Blue green color
saponins	Hg Cl2 5%	+	+	+	White precipitate

(+)positive (-) negative

Table(4)
Antibacterial Activity of standard Antibiotics presented by inhibition zone diameter (mm)

standard Antibiotic	Concentration	E.coli	S.aureus

Erythromycin	15ug	40	23
Fusidic acid	10ug	-	10
Neomycin	30ug	-	18
Streptomycin	10ug	25	20
Tetracycline	30ug	31	25

Discussion

The result reported in this study show that three Aspergillus species extracts process antibacterial activity against two bacteria E.coli and S.aureuss . the antibacterial activity of Aspergillus extracts are similar to a number of secondary metabolites activity isolated from A.nidulans,Adeflectus and terreus(6,19)

Antibacterial activity of three fungal extracts may be done as reason of chemical compounds that investigated in our studies such as alkaloids,tannins,phenols,saponins and flavonoids. The presence of this compounds in the extracts shows that the extracts were of pharmacological importance (1).

(20)record that the presence alkaloid, tannis and saponind enhanced the antibacterial activity against the broad spectrum of organisms.

Many interpene saponins and their glycones have been repoted by (12)to have vaied uses as antiukerogenic, antiinflamotary,fibrinolytic and anti-edematous in action

Conclusion

Fungal species produce compound with antibacterial activities.The extracts of fungal Aspergillus species have bioactive compounds such as alkaloids, phenols, tannins and flavonoids.The organic extract of A.niger was showed higher antibacterial activity against tow bacteria compared with another tow species used in this study.

Recommendation

Purification of the secondary metabolites and study the Characterization of the purified active compound by 1- Infra Red spectra 2- Mass spectroscopy .

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تقيم الفعالية ضد البكتيريه لبعض المركبات المستخلصة من ثلاثة انواع من فطر Aspergillus

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الخلاصة :

تم تقيم الفعالية ضد البكتيرية لعبض المركبات المستخلصة من ثلاثة انواع من فطرAspergillus وهي (A.niger A.terrus, and A.flavus) باستخدام Kirby Bauer diffusion test ضد نوعين من البكتيريا السالبه والموجبه لصبغة غرام (Escherichia coli and staphylococcus aureus) حيث تم استخلاص المركبات من المزرعة الفطرية باستخدام الاثيل استيت كمذيب عضوي ،اظهر مستخلص (A.niger) فرقا معنويا بامقارنة مع بقية الانواع ،كما بينت الدراسة ان كل المستخلصات الفطرية كان لها نفس التركيب الكيمياوي والمتمثل بالالكولويد،التانين،الصابونين والفلافونويد.