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Influence of Purification by Bio-Activated Carbon on Rabbit Urine Components

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ABSTRACT

Treating the liquids of the organic animal urine loaded with microbial materials is highly significant. So, employing bio-activated carbon (AC) for rabbit urine purification is a major factor in avoiding and spreading diseases. The rabbit urine may be used after treating as a good bio-fertilizer. Therefore, this research aims to identify the best components for bio-filter to purify and treat rabbit urine can used. The investigated bio-filter components were: I- Two layers of filter paper + one layer of "AC" with 5.0 cm height, II- Two layers of filter paper + one layer of AC with 5.0 cm height between two layers of sand with 4.0 cm height, and III- Two layers of filter paper + one layer of cork with 1.5 cm height + one layer of AC with 5.0 cm height + one layer of cork with 1.5 cm height + one layer of sand with 4.0 cm height + one layer of cork with 1.5 cm height. The measurements were conducted to determine the quality of the liquid produced as standard fertilizer under different treatments in three replications. The results indicated that the possibility of applying AC, which was made from date palm kernels, as a bio-filter media. This bio-filter was acceptable with all the tested treatments due to the ability to purify impurities such as; aspect (light to clear), sedimentation, pH (5.0 to 6.0), pus cells (3.0 to 6.0), red blood cells (1.0 to 4.0), organisms (non), and colony count (non).

***Keywords*:** Liquid residues, Organic fertilizer, Date kernel, Coconut shell, Treating organic materials

INTRODUCTION

The produced liquid from: farms of fields, poultry and animals; may be used. It can be treated these liquids and reused in different human practices. The bio-treated materials as the activated carbon which is produced from the agriculture residues is effective for treating the farm liquids. Many researches explained that activated carbon as a purification material can be manufacture from agricultural residues. The activated carbon may be manufacture from date kernel, corn stalks, residues of trimming trees; peach banana peel and cotton clothing residues. Also, they concluded that activated carbon made from the date kernel is considered the best for treating wastewater [Kim *et al*. (2022); Lotfy and Roubik (2021); Maia *et al*. (2021); Amer (2017) and El-Raie et al. (2016)].

Joshi *et al*. (2022), Fito and Van Hulle (2021) and Kumari and Annamareddy (2020) cleared that the process of water purification is removing unwanted chemical and biological contaminants from raw water. It employs physical processes like filtration and sedimentation, biological processes as sand filters or activated carbon, or using chemical processes like flocculation or chlorination, and finally, using electromagnetic radiation like ultraviolet radiation. The wastewater qualification criteria after treatment that include electrical conductivity (EC), total dissolved solids (TDS), and sodium adsorption ratio (SAR). The other parameters to consider before applying wastewater for fertility of agricultural lands include suspended materials and organic matter (Koupai and Bakhtiarifar, 2004). The salt content and the suspended solids are the most two main processes that affect the physical properties of the soil during wastewater is used.

Generally, organic fertilizers have high efficiency and less biological damage than chemically. Also, their harm is almost nonexistent indicated by Jaja and Barber (2017) and Rahimi *et al*. (2021). Usually, the organic fertilizers or organic materials include a vital chemical element that could improve macro and micronutrients (N, P, K, Ca, Zn, Cu, and Mo) in different amounts (Abustam et al., 2018 and Izaurralde *et al*., 2000). Haugen *et al*. (2005) reported that a rabbit can produce about 25-100 ml of urine per day. Afresh urine contains ammonia (NH_3), colorless gas that is lighter than air and has a strong odor. Protein digestion results in ammonia and other nitrogenous gases, part of it lost in manure and urine. The recommendation by Greendale Veterinary Diagnostics (http://www.greendale.co.uk, 2022) is that rabbit urine is turbid and alkaline around 8 - 9, as they are herbivores. The daily volumes range from 20 to 350 ml/kg and the specific gravity varies due to the organization of mineral deposits which ranged between 1.003 and 1036 $g.cm^{-3}$. Also, traces of glucose and protein may be present.

Tortora *et al*. (2001) and Ahmad *et al*. (2022) stated that the microbial decomposers treated to improve the organic fertilizer significantly. Also, Boswell *et al*. (1997) signed that Pseudomonas is a bacterial genus that plays a critical role in nitrification. Similarly, urea is an inorganic fertilizer that comes in the form of a white crystalline solid that is highly soluble in water and contains 46% nitrogen. So, as recommended by Indabo and Abubakar (2020), farmers should apply rabbit urine (¼ liter) in addition to the recommended fertilizer dose (250: 250: 250 kg of N: P: K)

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for improved agronomic parameters and yield. This urine may be dangerous if it is contained of nurse organisms. Therefore, it must be treated for safe use as fertilizer without infection of the soil, animals, plants, and human.

The aim of this research is evaluation of the best bio-filter construction that can use to treat the rabbit urine for use as organic fertilizer by:

1- Knowing the quality of the liquid residue produced from rabbit farms as fertilizer.
2- Determine the best bio-filter components designed to get out of pathogenic microbes.

MATERIALS AND METHODS

Experiments were carried out at Ismail laboratory of power and farm machinery, Agric. Eng. Dept., Fac. of Agric., Mansoura University, Egypt, from 2019 to 2021. The following steps are identified to achieve the goal of this research:-

Preparing the test filter

The simple components arrangement in a bio-filter was using an injector of 18.15mm diameter. The injector was put in the scale tube to collect the treated water (Fig. 1).

The filter media

The media inside the filter includes three types of activated carbon and different layers from; cork, sand and paper nominations. The properties of activated carbon types were tabulated in Table (1).

Rabbit urine properties

The rabbit urine can use as good organic fertilizer, but it has a dangerous pathogenic. The specification and physical properties of rabbit urine are tabulated in Table (2).

The experimental procedure

Samples were collected by preparing a battery of 8 New Zealand mother rabbits from 2.5 to 3.0 kg. The 10-liter tank is put below the battery to receive the amount of urine for days "800 to 1000 ml/day". The ingredients for the purification procedure were prepared using the activated carbon. It is prepared by placing it inside the crucibles of the drying oven at a temperature of about 225 °C for 4 hours (determined as test the AC quality). Thus, the activated carbon and the liquid samples become ready to start the experiments.

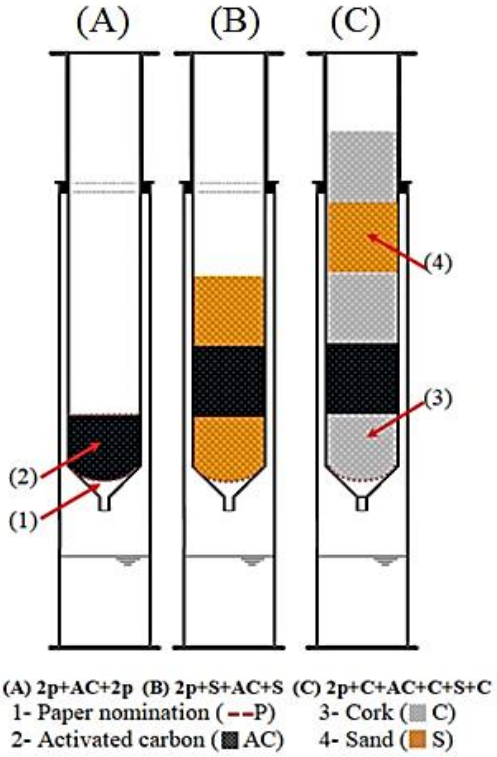


Fig. 1. The components of test filters

Table 1. Some properties of the activated carbon (AC)

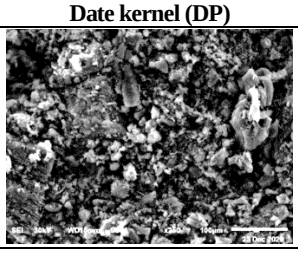
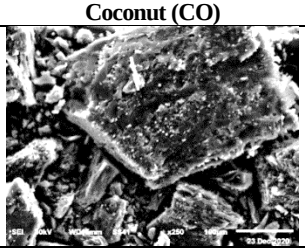
Properties	Activated carbon types		
	Date kernel (DP)	Coconut (CO)	Local market (LM)
SEM			
Surface area, m^2g^{-1}	951	1054	560
Total pore volume, cm^3g^{-1}	0.456	0.517	0.292
Bulk density, gcm^{-3}	1.8	0.75	0.35
Moisture content, w.b., %	0.4	0.35	0.94

Table 2. Properties urine samples before filtration

Physical	**Color**	**Odor**	**Aspect**	**Deposit**	
	Dark yellow	**Aromatic**	**Turbid**	**Absent**	
Chemical	Nitrite	pH	Specific gravity	Protein	EC, ppm
	(+ + +)	> 15	1020	Absent	149
Microscopic	Pus cells, hpf	Red blood cells, hpf	Epithelial cells	Amorphous	
	0 – 10	0 - 7	Few	Phosphates + + +	
Culture	Organism	Culture condition	Colony count		
	E. coli	On nutrient ager for 48 hours aerobically	More than 10.000 bacteria / ml		

During the components arrangement in a bio-filter (C), it was taken into account to get rid of large impurities using layers of sand and cork and to get rid of fine impurities using activated carbon. The studied variables are types of activated carbon (date kernel, coconut, and local market) under the components arrangement in a bio-filter (paper nomination, sand, and cork) as shown in Fig. (1) and illustrated as follows:

- **Filter (A),** It is arranged from two layers of nomination paper on both sides before and after the activated carbon layer. The layer of activated carbon was stabled at the height of 5.0 cm in the injector tube.
- **Filter (B),** It is arranged from two layers of paper nomination, then height of 4.0 cm of two layers sand before and after one layer of "AC" under the same above height.
- **Filter (C),** It is arranged from two nomination paper layers followed by one layer of activated carbon with a height of 5.0 cm and a layer of the sand height of about 4.0 cm. Then, the three cork layers of 1.5 cm height after each of the above filter layers.

The measurements were done by taking three samples of 20 ml before purification and getting sample about 12 ml after treatments. Then, the measurements were; the filtration flow rate, as the rabbit urine amount in standard time, ($ml.h^{-1}$) and some important analysis which were done in a special analysis lab. (Medicinal methods). Each analysis repeats three times. The analyses were classified into four types, as follows:

1- Physical tests; include the color degree using spectro-photometer device, odor, aspect and deposit.
2- Chemical examination; Medi-Test Combi 10R SGL is easily and common method. Each paper stalk contains ten different chemical reagents. The change in color of paper-stalk, when dipped inside the sample (5 ml) after 5 Sec, is recorded as data according to the list from the code bar of Medi-Test Combi 10R SGL. The main tests in this research are nitrite, pH, specific gravity, and protein.
3- Microscopic examination; is entirely dependent on the microscope, with a drop of the sample placed on the microscope slide and the results of pus cells, red blood cells, epithelial cells and amorphous recorded.
4- Culture examination; recorded by determining whether the samples contain pathogenic bacteria and the ability of activated carbon to absorb them. This test is done by taking the sample, then distributing it on natural agar in Petri dishes. The type of growing bacteria were recorded.

The experimental design is the randomized complete block design in three replicates. Then the standard deviation and the coefficient of variance were determined for the urine flow rate and acidity.

RESULTS AND DISCUSSION

The purification media of filters

The filters flow rate

Fig. (2) illustrated the effect of types of activated carbon on urine flow rate at different filter constructions. The figure cleared that the highest flow rate found at AC of LM of 8.00 $ml.h^{-1}$ and the lowest was showed at AC of CO of 2.44 $ml.h^{-1}$. These results are due to the establishment of a fine-grained arrangement that led to the formation of capillary tubes clumps, resulting in a high flow rate.

The opposite results are clear in coarse-granules at "DP". On the other side, at all AC the constructed filter "A" is the highest, followed by filter "C" and then filter "B". The performance of filters "B" and "C" had slightly different. The filter "A" has the effect construction. That means the AC is the main material effect on the urine flow rate.

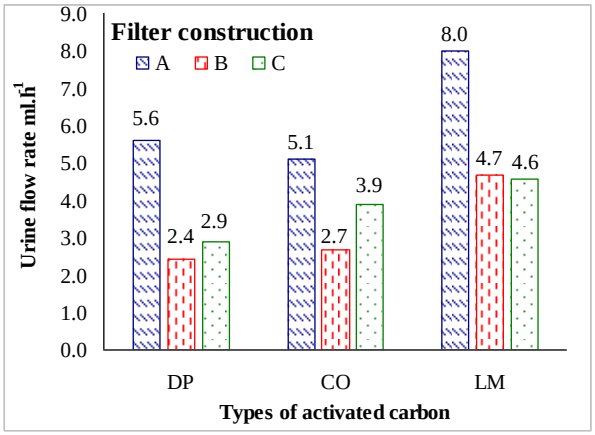


Fig. 2. Effect of activated carbon types on urine flow rate

Physical properties of urine exiting from filters

Tables (2 and 3) cleared some physical properties of rabbit urine before and after purification. These properties are color, odor, aspect and deposit. The tested views explained that the urine sample before tests (Table 2) had dark yellow in color, aromatic in odor, turbid in aspect and absent deposit. These properties changed after purification (Table 3) as amber limpid, amber yellow and limpid in color using filter media of activated carbon from the date palm, coconut and local market, respectively, when using filter (A). Therefore, the color of samples using filters (B and C) were amber limpid, yellow and amber limpid in color using filter media of activated carbon from the date palm, coconut and local market, respectively.

Table 3. Effect of purification media on some physical properties of rabbit urine

Filter construction		Physical properties	Activated carbon types		
			Date palm (DP)	Coconut (CO)	Local marketing (LM)
(A)	2p+C+2p	Color	Amber limpid	Amber yellow	Limpid
		Odor	Aromatic	Aromatic	Aromatic
		Aspect	Lightly turbid	Turbid	Lightly turbid
		Deposit	Absent	+ + +	+
(B)	2p+S+AC +S	Color	Amber limpid	Yellow	Amber limpid
		Odor	Aromatic	Aromatic	Aromatic
		Aspect	Clear	Turbid	Lightly turbid
		Deposit	Absent	+ +	+
(C)	2p+C+AC+ S+C	Color	Amber limpid	Yellow	Amber limpid
		Odor	Aromatic	Aromatic	Aromatic
		Aspect	Clear	Turbid	Clear
		Deposit	Absent	+	+

Recording the difference of color data referring to the ability of the "AC" and the "FC" can absorb the color by different ratios. The highly absorbed "AC" made from the local market than AC from date palm and coconut may be because of the fine particles which vary a countless particle surface area. Also, they absorb color by increasing the filter layers are about stable because the different filter layers had a slight effect on the absorption of color from urine. The odor were non records any change. The non-change in odor because of the properties waste-water and it may to the specification of the AC which can't absorb the odor.

Moreover, the aspects properties were lightly turbid at filter "A" and strong at both of filters (B) and (C) through the filter media of DP. While using the filter with

media of CO it was turbidly using the three filters constructed. Consequently, the aspects properties were lightly turbid and lightly turbid clear sing filters (A), (B), and (C), respectively, using the filter media of local market activated carbon "LM". The aspect data degree was found for using the fine particles of AC. It recorded for "DP" following by "LM" and "CO" for all filter constructions. However, the deposit properties were absent in all filter construction using the filter media of "DP" activated carbon. On the other side, the deposits were high, moderate, and slight using filters (A), (B) and (C), respectively, using "CO". The data of deposits using the "LM" were stable at a slight level for the three filter components. The absent deposit at using AC of DP at all filter structures may be due to the ability of the "DP AC" to absorb it. But, the other AC used in the experiments hasn't the same effect. It is due to the properties of raw materials and effect of their properties in the process of AC.

Chemical properties of urine exiting from filters

pH of urine exiting from the filter

In Fig. (3) declined the urine pH at different filter components using the activated carbon types. The figure demonstrated the recorded pH values using AC of DP were 5.0, 6.0 and 5.5, respectively, at the constructed filter of A, B, and C. Furthermore, using AC of CO the highest pH values of "9.0, 9.0, and 8.0" were found, respectively, at constructed filters of A, B, and C. Also, using AC of ML highest pH values of 8.00 ml.h-1 and the lowest of 2.44 ml.h^{-1} were found at AC of CO.

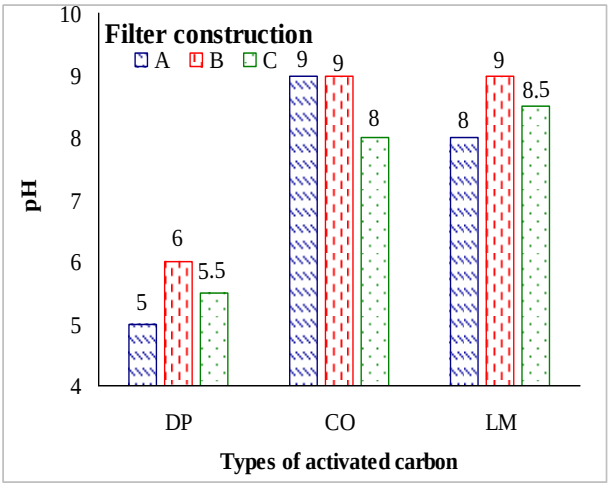


Fig. 3. Effect of activated carbon types on urine pH

The above results cleared the ability of each constructed filters using AC of DP to improve the pH of rabbit urine compared with the other AC types. The pH results for rabbit urine after treated were agreement with the explained by Greendale Veterinary Diagnostics (http://www. greendale. co.uk, 2022).

Specific gravity of urine exiting from the filter

Fig. (4) cleared the effect of activated carbon types on urine-specific gravity at different filter constructions. The figure confirmed the recorded urine-specific gravity values using AC of DP and CO were stabled at 1025 and 1010, respectively, at the all-constructed filters of A, B, and C. Thus, using AC of LM, the urine-specific gravity values stabled at 1010 at using constructed filters B and C. But, it recorded 1015 for construction of filter A. These results found the specific gravity of treated rabbit urine ranging from 1010 to 1025 that was reported by Greendale Veterinary Diagnostics (http://www.greendale.co.uk, 2022). Hence, both the nitrate and protein components were recorded as slight amounts in all test samples after treatment of rabbit urine.

The microscopic checkup of rabbit urine

Tables (2 and 4) showed microscopic checkups of rabbit urine before and after purification. These checkups include Pus cells "h.p.f"; Red blood cells "h.p.f"; Epithelial cells and Amorphous. The tested views that the urine samples before treatment (Table 2) had Pus cells were about 0 - 10 h.p.f, Red blood cells ranging from 0 - 7 h.p.f, little concentration of Epithelial cells and high concentration of Amorphous phosphates.

After urine samples purification (Table 4) under different filters media, the variation of the above contents indicated that:-

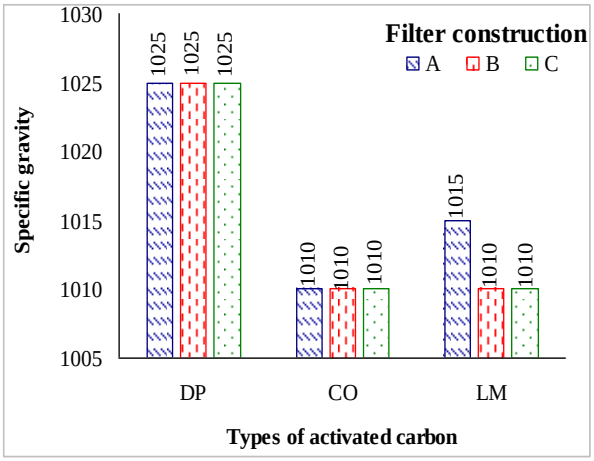


Fig. 4. Effect of activated carbon types on urine specific gravity

Table 4. Effect of purification media on microscopic checkup of rabbit urine

Filter construction		Microscopic checkup	AC types		
			Date palm (DB)	Coconut (CO)	Local marketing (LM)
(A)	2p+AC+2p	Pus cells, h.p.f	4 - 6	4 - 6	8 -10
		R.b.cs, h.p.f	2 - 4	3 - 5	2 - 4
		Epithelial cells	Nil	Nil	Nil
		Amorphous	Urates +	Triple phosphate +	Phosphate + +
(B)	2p+S+AC+S	Pus cells, h.p.f	3 - 5	8 - 10	8 - 10
		R.b.cs, h.p.f	1 - 3	2 - 4	5 - 7
		Epithelial cells	Nil	Nil	Nil
		Amorphous	Urates	Triple phosphate +	Phosphate + +
(C)	2p+C+AC+S+C	Pus cells, h.p.f	3 -6	3 -5	7 - 9
		R.b.cs, h.p.f	2 - 3	3 - 5	2 - 4
		Epithelial cells	Nil	Nil	Nil
		Amorphous	Urates +	Triple phosphate + +	Phosphate + +

- For filter (A), the Pus cells were 4 - 6 & 4 - 6, and 8 -10 h.p.f and the Red blood cells ranged from 2 – 4 & 3 - 5, and 2 - 4 h.p.f per using filter media of activated carbon from the "DP", "CO" and "LM" respectively. Moreover, the concentrations of Epithelial cells were recorded as nil using all filter media. Also, Amorphous were found little from urates, triple phosphate, and moderate phosphate using activated carbon from the "DP", "CO" and "LM" respectively.
- For filter (B), the Pus cells were ranged from 3 – 5 & 8 - 10 and 8 - 10 h.p.f. Also, the Red blood cells ranged from 1 – 3 & 2 - 4 and 5 - 7 h.p.f, respectively, using filter media of activated carbon form the "DP", "CO" and "LM". However, the concentration of Epithelial cells were recorded nil using all filter medias. Moreover, the concentrations of Amorphous were found little from urates, triple phosphate and moderate phosphate using activated carbon form the "DP", "CO" and "LM" respectively.
- For filter (C), the Pus cells were ranged from 3 – 6 & 3 - 5 and 7 - 9 h.p.f. Also, the Red blood cells were ranged from 2 – 3 & 3 - 5 and 2 - 4 h.p.f, respectively, using filter media of activated carbon form the "DP", "CO" and "LM". However, the concentration of Epithelial cells were recorded nil using the all filter medias. Moreover, the concentrations of Amorphous were found little from urine, triple phosphate and moderate phosphate using activated carbon form the "DP", "CO" and "LM" respectively.

The culture test of rabbit urine

Tables (2 and 5) show the results of culture tests for rabbit urine before and after tests. From Table (2), the urine culture was cleared, and the highest organisms (E.colii) recorded more than 10.000 bacteria/ml. While Table (5) recorded that the AC from DP and ML can absorb all organisms and colony count bacteria from rabbit urine. Nevertheless, the AC from CO cannot absorb the organism of Gram-negative bacilli (more than 10.000 bacteria/ml).

Table 5. Effect of purification media on culture test of rabbit urine at different filter component

	Organism	Colony count
Date palm (DP)	NO Organism	No bacteria
Coconut (CO)	Gram negative bacilli	More than 10.000 bacteria / ml
Local market (LM)	NO Organism	No bacteria

CONCLUSION

The results concluded that the activated carbon used as a bio-media for treating rabbit urine is mainly made from kernels of date palm. It is acceptable with all groups of filters under test because of its ability to purify impurities such as aspect (light to clear), sedimentation, pH (5.0 to 6.0), pus cells (3.0 to 6.0), red blood cells (1.0 to 4.0), organisms (non), and colony count (non).

This research has been registered for a patent at the Academy of Scientific Research and Technology, Egypt (Request No. EG/P/2022/1591)

List of abbreviations

AC: Activated carbon	C: Cork	CO: Coconut
DP: Date palm	EMS: Electronic Microscope Scan	
LM: Local market	P: Filter paper	S: Sand

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تأثير التنقية بالكربون الحيوى المنشط على مكونات بول الأرانب

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الملخص

معالجة المواد العضوية السائلة الناتجة من بول الحيوانات، والتى قد تكون محملة بالمواد الميكروبية، قبل توجيهها للإستخدام كسماد، هام من حيث تجنب التعرض للإصابة بالأمراض المختلفة وزيادة إنتشارها. لذا يهدف هذا البحث إلى التعرف على أفضل مكونات لفلتر حيوي يمكن استخدامه لتنقية وعلاج بول الأرانب حتى يمكن إستخدامه كسماد عن طريق معرفة جودة المخلف السائل المعالج الناتج من بول الأرانب. ويتكون المرشح الحيوي المقترح من: 1- طبقتان من ورق الترشيح + طبقة واحدة من الكربون المنشط "AC" بارتفاع 5.0 سم، 2- طبقتان من ورق الترشيح + طبقة واحدة من AC بارتفاع 5.0 سم بين طبقتين من الرمل بارتفاع 4.0 سم، و3- طبقتان من ورق الترشيح + طبقة واحدة من الفلين بارتفاع 1.5 سم + طبقة واحدة من AC بارتفاع 5.0 سم + طبقة واحدة من الفلين بارتفاع 1.5 سم + طبقة واحدة من الرمل بارتفاع 4.0 سم + طبقة واحدة من الفلين بارتفاع 1.5 سم. أجريت القياسات لتحديد جودة السائل الناتج كسماد تحت معاملات مختلفة بثلاث مكررات. أشارت النتائج إلى إمكانية إستخدام الكربون المنشط المصنوع من نوى البلح كوسيط حيوي للترشيح. كان هذا المرشح الحيوي مقبولاً مع جميع المعالجات المختبرة نظرًا لقدرته على التنقية من حيث أنه ذو مظهر مضئ ورائق، لا يوجد به ترسبات، درجة الحموضة (5.0 إلى 6.0)، خلايا القيح (3.0 إلى 6.0) ، خلايا الدم الحمراء (1.0 إلى 4.0)، لا توجد خلايا كائنات حية، وتوجد بعض البكتريا الغير ممرضة.