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Industrial Preparation Method for Liquid Organic Fertilizers from Fish Residue and Determination of Their Elements Content

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Abstract:

Liquid organic fertilizers have been used in several applications in agriculture field due to their unique properties, like their ability to deliver nutrients and improving long-term soil health. So, in this study, new liquid organic fertilizers were prepared using cheap manner which contain fish waste and residues. The waste was first cut and then treated with concentrated phosphoric acid to prepare several samples in different pH (1-2, 3-4 and 5-6), and in different temperatures (45-60 and 65-80 °C), with and without oxygen. After that, the prepared samples were neutralized and filtered to get a liquid layer which underwent to NPK measurement (NPK refer to contains of nitrogen (N), phosphorus (P) and potassium K) to estimate the percentage of contains of Nitrogen, Phosphorus, Potassium, Manganese, Iron and Sulfur elements.

This method is considered as efficient, novel, and environmentally benign steps. Moreover, it is known that the liquid organic fertilizers now are used as an effective and suitable alternative to the conventional solid organic fertilizer and chemical fertilizer. In our country, this technique is not popular hence this should be spread

among fish sellers, researchers and common people omit. This will be helpful to generate employment. Fish remains can be turned from “waste” into wealth i.e. waste to best, not only for environment and agriculture, but also for fishery industry.

Keywords: liquid organic fertilizers, NPK, fish wastes and residues, materials.

INTRODUCTION:

Agriculture is one of the main basics that the national economy of most countries depends on. So, this sector should be developed and efforts should be exerted to maintain it and enhance it by developed techniques notably by agricultural research and using fertilizers are of the top priorities of most of those who are interested in agriculture. Generally speaking, fertilizers are organic and non-organic materials used to feed plants and improve the chemical, physical and vital features of the soil [1]. Using these fertilizers, especially the organic ones, affects positively on the product of plants. So, it can be concluded that the organic fertilizing process is the corner stone which should be considered and used to increase the productivity of the agricultural lands which, in turn, participates very actively in decreasing environmental pollution, whose main cause is the over-use in chemical mineral fertilizers. Organic fertilizers whether liquid or solid, play a vital role in the growing of agricultural crops and they affect the features of the soil via improving the soil structure and organizing its fertility regarding the acidity of the soil and increasing the ability to exchange positive ions which are called (Cations). Besides, the organic fertilizers supply the plant with the nutritional elements which are released from organic compounds during their dissolution. They participate in increasing the biological activity inside the area of root spread. Fertilizers, in general, can be classified into various types, organic fertilizers, chemical fertilizers, mineral fertilizers and others. All kinds of fertilizers contain one of the important and necessary nutritional elements needed for the growing of plants which are nitrogen, phosphorus, potassium, etc, [2]. It has been scientifically and practically proved that nitrogen, for instance, is present in the composition of cells in plants and also in the composition of the chlorophyll

whereby, its shortage makes the leaves yellow and leads to low productivity besides the considerable role of both the phosphorus and the potassium in the growing of plants and the roots as well as reinforcing the soil. Most farmers resort to using chemical fertilizers or solid fertilizers and solid sewage waste as well as municipal compost on a large scale. They are not devoid of defects and negative aspects; they all contain heavy elements which may accumulate in the soil and harm soil, plants and animals. The use of such compost must be based on certain considerations related to compost, soil and crops [3]. For example, the plant (Aleqhawan) which is sensitive to chemical fertilizers [4,5] and which is used for medical, decoration and cooking purposes and which is cultivated on vast areas all over the world, the over-use of chemical fertilizers has affected considerably on the productive power to a great extent of this plant besides the effect on the quality of the soil and caused dangerous environmental problems, [6,7]. Several studies focus on the replacement of the used chemical fertilizers by organic ones which differ from the first in that they are characterized by activity in environmental sustainability and plant growth. At first, the used fertilizers depend on the traditional solid organic fertilizers such as hay and manure, [8,9]. However, after the emergence of liquid organic fertilizers from natural sources which are rich in organic substances and which have proved to be active in increasing product and preserving and sustaining the soil and plant health, the demand for them became more than that on the other fertilizers, [10,11,12]. Many studies have proved that the liquid organic fertilizers have actively strengthened the growth of the roots of the tomato plant, [13,14]. The liquid organic fertilizer is considered more effective than the normal organic fertilizer. That is so due to the matter's properties; the liquids penetrate though the soil more quickly to be absorbed by the roots of the plants more efficiently compared with the normal fertilizer which needs more time to be absorbed by the roots.

EXPERIMENTAL PART

The Practical Part

The practical part depends on the use of fish compost (all the guts of the stomach of the fish), then guts are taken and subjected to many operations which are: (mechanical digestion, chemical digestion, standardization and (NPK) measurement.

Mechanical Digestion

The first step contained the process of mechanical digestion by grinding, whereby the guts of the fish are cut and carefully grinded in the mixer for an hour, after that the mixture was heated under stirrer to boiling degree for three hours.

Chemical Digestion

In this step, the compound was undergone to chemical digestion by using drops of concentrated phosphoric acid to adjust the suitable pH, whereby the outcome of the first step is divided into many parts to prepare several samples with different (pH). The outcome of the first step is divided into three parts with the addition of the phosphoric acid with continuous moving and keeping the (pH) controlled for each sample (Table 1), then the hydrogen index is gauged:

The pH for the first sample was (2-1), while the second sample was (3-4) and finally the third one at (5-6). After that, two variables are covered which are temperature and the existence of air (Oxygen), whereby each part of the second step (Chemical Digestion) is divided into many parts.

Experiments were conducted under various temperatures; the first was done at (45-60 °C), the second at (65-80 °C). Each sample, under these varying degrees, is divided into two parts, one with air (oxygen) via pumping air bubbles inside the vessel and the other without air. The mixture is stirred for 24 hours for all samples.

Some of the resulting compounds were neutralized from the acid using the gas by passing through them, while the other samples were left for five days to get self-neutralization. After that, All the samples were filtered to take the liquid part which

constitutes the liquid organic fertilizer, and the (NPK) is measured to determine the rates of Nitrogen, phosphoric, potassium, Manganese, Iron and Sulfur elements.



Figure 1- The Result of the Mechanical Digestion of the Fish Guts before and after Heating.

Estimating the Content of the Fertilizer from the Nutrition Elements

The nitrogen was estimated in the prepared samples using (Kjeldahles Method) which is available in the Central Laboratory of the Higher Studies – college of Agriculture-Baghdad University, also the rates of both the phosphoric and potassium were estimated in the same laboratory.

While the proportion of micro-elements (Manganese, Iron and Sulfur) were measured at the University of Mosul, College of Basic Education-Science Department, using a device (Sens AA, GBC scientific equipment), using different concentration of extracted products as shown below in the discussion part.

RESULT & DISCUSSION:

Fertilizers have become indispensable for agricultural crops, especially after the emergence of desertification in lands and the agricultural areas, the shortage in lands and other problems which disturb the world. Farmers nowadays use large quantities of fertilizers yearly all over the world. The increase in product, thanks to the addition of fertilizers, is about quarter of the global product. Without fertilizing, more lands should be cultivated, and more workers should be employed to produce the same quantity. The project of producing liquid organic fertilizers is considered one of the vital and

environmental pioneering projects which aims at ensuring the most excellent organic fertilizers for omit those working in the sphere of agriculture as well as protecting the environment for it prevents the accumulation and the spreading of animal and plant compost or burning the compost and consequently polluting the environment considerably. There are various sources for extracting and manufacturing liquid organic fertilizers, that depend on the algae, the remains of fruits and plants in some ways.

This research focuses on the production of liquid organic fertilizers from natural raw materials which are not chemical and are not harmful to the environment. These materials are namely guts of fish. As is known, Iraq is rich with many kinds of fishes so, large quantities of these fertilizers can be produced and made use of with low cost.

The practical part includes several variables which are:

1- Mechanical digestion which includes cutting and grinding the compost with the use of mixers.

2- Chemical digestion by way of controlling the concentration of the acid, whereby, we relied on using the concentrated phosphoric acid with due regard to the preparation of many samples with various (pH) for comparison, the (pH) includes (1-2-3-4) and finally (5-6). As for the other variable, which is temperature, these already prepared samples were heated to a temperatures (45-60, 65-80 °C). The last variable was oxygen (i.e. the existence or absence of air), whereby, the variables (temperature and the hydrogen index) were fixed, and air bubbles were pumped inside some of these samples, and their absence in other samples (at the same temperature and the hydrogen index) also for comparison purposes.

The period of heating and moving was the same period (24 hours), after these steps were the process of filtering the outcome and taking the liquid part (because the objective of the work is to prepare liquid fertilizers). Finally, the acid was neutralized by pumping the A gas bubbles, at last, some results were selected with varying conditions and specifying them by using the (NPK) measures (measuring the rates of nitrogen, phosphorus and potassium) which are the three important and nutrition elements for both plants and soil. The results were good as shown in table No. (1):

Table 1: The Rate of the Nutrition Elements (N, P, K, Mn, Fe and S) in the prepared samples

No. Sample	Micro elements					
	Nitrogen (ppm)	Phosphorus (ppm)	Potassium (ppm)	Manganese (ppm)	Iron (ppm)	Sulfur (ppm)
1	3.26	0.727	0.624	1.38	2.96	2.96
2	3.07	0.917	0.778	1.97	1.34	1.34
3	1.70	1.361	0.601	1.94	3.22	3.22
4	2.99	0.885	0.595	1.46	3.12	3.12
5	2.96	1.263	0.741	2.20	1.72	1.72
6	1.34	1.188	0.630	2.12	3.17	3.17
7	3.43	1.650	0.559	2.40	5.43	3.43
8	3.12	1.240	0.718	2.48	1.5	1.50
9	1.72	1.535	0.611	2.32	3.26	3.26
10	3.22	1.258	0.657	1.54	3.03	3.03

Experiment Conditions			
Sample No.	Heating Temperature	Presence of Oxygen	pH
1	65-80	√	1-2
2	65	X	1-2
3	65	√	3-4
4	65	X	3-4
5	65	√	1-2
6	65	√	3-4
7	65	√	5-6
8	45-60	√	1-2
9	45	√	3-4
10	45	√	5-6

Table 1: The Rate of the Nutrition Elements (N, P, K, Mn, Fe and S) in the prepared samples which were measured in the Central Lab of the Higher Studies- College of Agriculture- Baghdad University. (√ means the presence of Oxygen, while x means the absence of Oxygen).

The chemical analysis data of liquid fish fertilizers were presented as proximate content of (N, P, K, Mn, Fe and S). Results showed that the highest degree of hydrogen was in sample No. (7), which was done at pH (5-6), in the presence of Oxygen and the heating temperature ranged from (65 to 80 degree centigrade). As for the element of lead, which is harmful to soil and plants because it is a toxic factor, the measurements have proved that the percentage was zero and this gives more importance to liquid organic fertilizers prepared in this research.

CAL	-----	4.60	0.0283	0.0278	0.0273	0.0298
BLANK						
Standard 1	1.000	HIGH	0.0027	0.0035	0.0015	0.0032
Standard 2	2.000	HIGH	0.0055	0.0029	0.0078	0.0056
Standard 3	3.000	3.51	0.0114	0.0115	0.0117	0.0109
Standard 4	4.000	17.23	0.0135	0.0109	0.0151	0.0146

Sample Label	Conc. (µg/ml)		%RSD	Mean Abs	Replicates	
sample 1	2.361	HIGH	0.0078	0.0067	0.0047	0.0120
Sample 2	3.341	HIGH	0.0111	0.0085	0.0106	0.0140
Sample 3	2.761	HIGH	0.0091	0.0133	0.0083	0.0058
Sample 4	3.367	HIGH	0.0111	0.0088	0.0162	0.0084
Sample 5	4.339	HIGH	0.0144	0.0123	0.0182	0.0126
Sample 6	4.060	HIGH	0.0134	0.0096	0.0220	0.0086
Sample 7	2.787	HIGH	0.0092	0.0081	0.0119	0.0077
Sample 8	4.157	HIGH	0.0138	0.0118	0.0096	0.0199
Sample 9	3.447	HIGH	0.0114	0.0161	0.0097	0.0083
Sample 10	12.58	HIGH	0.0176	0.0187	0.0191	0.0151

Table 2: Measurements of Manganese ratio

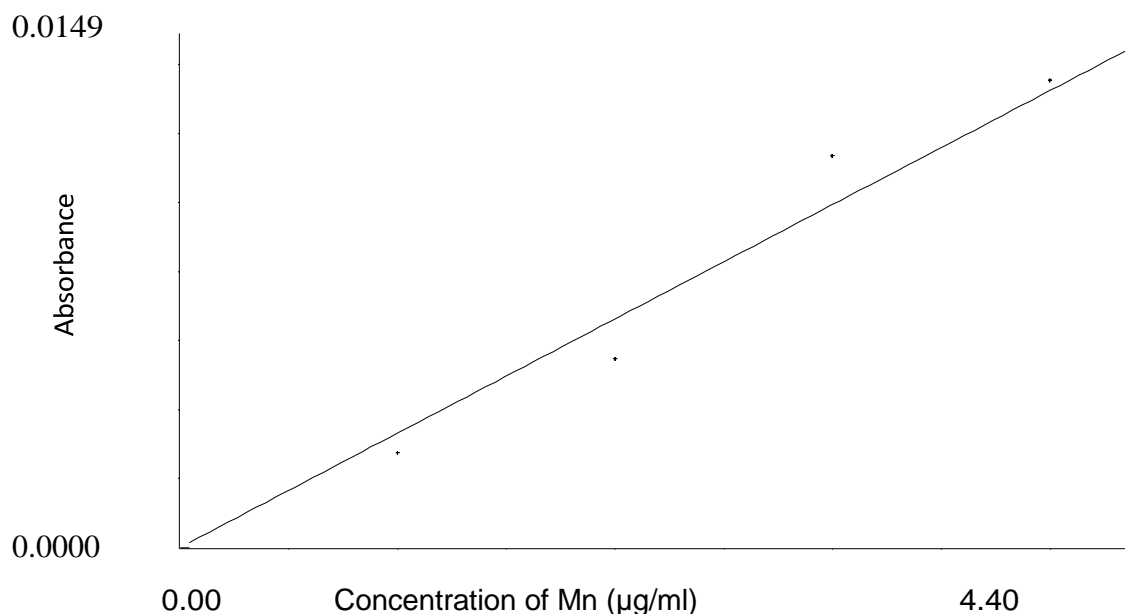
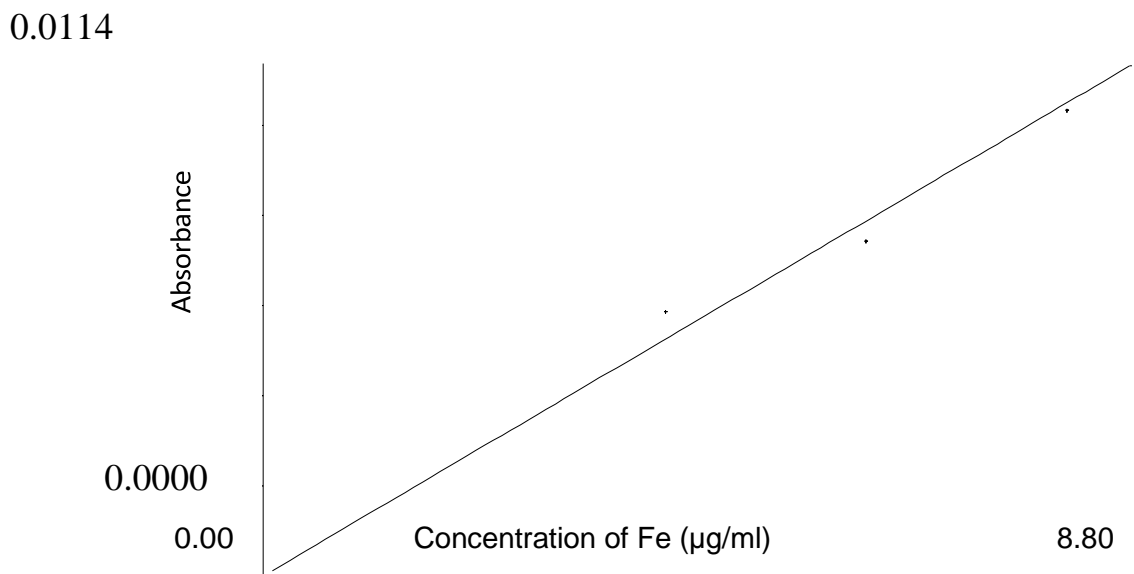


Table (3): Measurements of Iron ratio

Sample Label	Conc. (µg/ml)	%RSD	Mean Abs.		Replicates	
Cal Blank	-----	1.53	0.0452	0.0459	0.0452	0.0445
Standard 1	4.000	HIGH	0.0059	0.0068	0.0042	0.0066
Standard 2	6.000	0.65	0.0074	0.0074	0.0074	0.0075
Standard 3	8.000	HIGH	0.0103	0.0079	0.0102	0.0128

Sample Label	Conc. (µg/ml)	%RSD	Mean Abs.		Replicates	
Sample 1	1.213	HIGH	0.0016	0.0032	-0.0004	0.0019
Sample 2	2.316	HIGH	0.0030	0.0061	0.0026	0.0005
Sample 3	2.114	HIGH	0.0028	0.0045	0.0023	0.0015
Sample 4	1.765	HIGH	0.0023	0.0028	0.0035	0.0007
Sample 5	3.268	HIGH	0.0043	0.0011	0.0059	0.0059
Sample 6	0.474	HIGH	0.0006	0.0003	-0.0008	0.0024
Sample 7	4.283	HIGH	0.0056	0.0071	0.0041	0.0056
Sample 8	5.685	HIGH	0.0075	0.0075	0.0091	0.0058
Sample 9	5.939	HIGH	0.0078	0.0110	0.0066	0.0058
Sample 10	2.572	14.14	0.0034	0.0039	0.0029	0.0034



In comparison with what has been previously referred to by some sources (16) (about the content of the organic fertilizers or the remains of the nutrition elements) illustrated in table (4):

Table (4) shows a comparison of containing elements in prepared and commercial organic fertilizers:

Prepared liquid organic fertilizers	Stimplex fertilizer	Plant compost	Poultry manure	Sheep manure	Cattle manure	elements	No.
3.43	0.6	0.5-1.5	0.3-1.5	1.0-2.0	0.5-1.5	N %	1
1.650	0.10	0.3-0.6	1.0-2.0	0.3-0.6	0.2-0.5	P %	2
0.559	0.10	0.5-1.0	0.8-1.5	0.8-1.2	0.4-0.8	K %	3
2.40		0.002-0.008	0.01-0.02	0.005-0.015	0.003-0.01	Mn %	4
5.43		0.05-0.15	0.2-0.4	0.1-0.25	0.1-0.3	Fe %	5
3.43	0.2 – 0.4		0.3-0.5		0.2-0.3	S %	6

It is clear that the rate of the three important elements for soil and plants which are obtained from our work are very good and can be used effectively in the agriculture sector compared with some of the published references concerning the qualifications of the artificial organic fertilizer which requires that the rate of the nitrogen should not be less than (0.5%) [16]. Also, the rates which are obtained, if compared with the rates existing in some of the commercial fertilizers which are sold in markets such as the fruit color fertilizer which is of the fertilizers specialized in the speed of coloring the fruits naturally without any intrusion of any chemical compounds, the rate of nitrogen in it is (1.7%). Whereas the rates of the three nutrients nitrogen, phosphorus and potassium in Stimplex fertilizer are (0.6, 0.1, 0.1%) [17]. The activity of the organic fertilizer, which is prepared easily and the possibility of using it in the agricultural sector has become clear as shown above in the results of measuring of the device (Sens AA, GBC).

The results obtained were consistent with many references that proved the effectiveness of such fertilizers in improving agricultural production, as mentioned in the study like, seed immersion treatment using fish waste fertilizers gave a significant effect when compared to the control treatment. [18,19]

On the other hand, the growth of the other studies of onion and garlic using fish fertilizers were showed produced highest growing ratio compared to using chemical fertilizers. [20-22]

Although some elements such as (N, P, K, Mn, Fe) doesn't show direct absorption in the infrared (IR) spectrum and their peaks are not clearly appear, because they usually exist as isolated atoms or metal ions without covalent bonds capable of vibrational transitions, the measurements we carried out proved, albeit slightly, the existence of the atoms and elements that needed to be detected.

Their presence could be inferred from the characteristic absorption bands of functional groups or coordination bonds in which they participate, such as N-H, P=O, Fe-O, and Mn-O. In this study, the active groups in the prepared compound were also identified using IR, which clearly indicates the presence of nitrogen

groups that appear at the band ($3441 \text{ v}_{\text{max}}/\text{cm}^{-1}$) and phosphorus groups that appear at the band (1236 and 1099) (Figure 1).

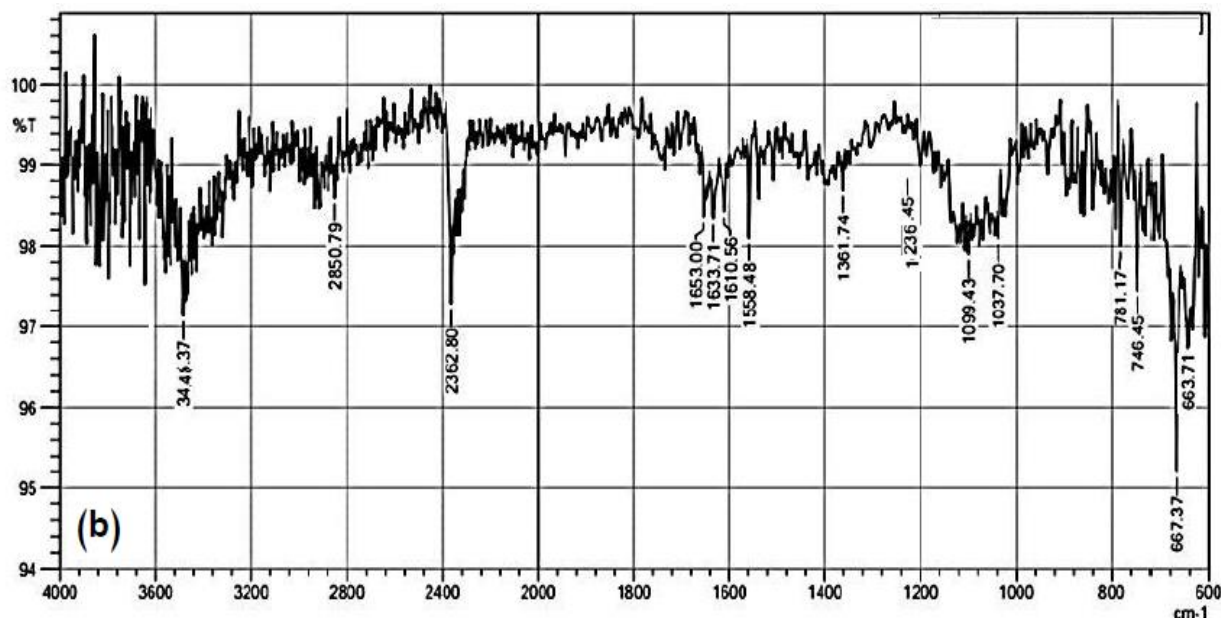


Figure 1. The IR spectrum for extract compound

CONCLUSION

The high prices of the chemical fertilizers and their negative impact on soil, humans and environment due to the recurrent use have driven farmers and growers to look for good alternative fertilizers. These are the organic fertilizers, especially the liquid type which meet the need by organic materials which in turn threatens most of the agricultural lands. Using liquid organic fertilizers is considered one of the fastest ways that brings life to both soil and plants. They work rapidly and promptly on supporting, spreading and growing of plants, besides that fact that they are rather less expensive and their little side effects compared with using chemical fertilizers. Based on the basis of the results obtained from our study which is characterized by easy preparation, low cost as well as the availability the raw material in omit Iraq and most Arab countries, omit the preparation of such fertilizers is recommended to be used to to increase productivity and maintain the fertility of the soil.

Composting of fish wastes methods of recycling organic waste with possible use in modern agriculture, and above all, an economic- ecological value and is regarded to be environmentally friendly. The study proved that fish waste can be a large source of NPK and other elements production and helpful to farmers for organic farming. Converting residue, the fish to Composting is a best way to eradicate waste to overcome the problem of pollution. moreover, It is safe and natural process and demolishes disease-causing organisms and flies larvae in addition it is considered as a cheap industrial method of fish waste disposal compared to other disposal alternatives. [23,24,25]

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