31 *Egypt. J. Soil Sci*. **Vol**. **53**, No. 4, pp. 461 - 474 (2013)

Manufacturing Amino Acids Biofertilizers from Agricultural Wastes. I- Usage of Tomatoes and Sugar Beet Straw to Prepare Organic Synthesized Fertilizers

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FOR RECYCLING of some agricultural wastes, tomato and sugar beet straw were used to produce different organic fertilizers. Six products of synthesized fertilizers were prepared at the laboratory of Regional Center for Food and Feed, Agricultural Research Center, Giza, Egypt. Amino acids were prepared by acid hydrolysis of the wastes using sulfuric acid (H_2SO_4, 6M) with the ratio of 1:3 (tomato or sugar beet straw: hydrolytic agent) under 105^{o}C for 24 hr into an air oven. For chelation of micronutrients, their salts in addition to boric acid were used. They were separately dissolved in 20 ml of distilled water and mixed with compound amino acids hydrolysis product then the whole mixture was diluted to 1L. The mixture was then kept on shaker for 4 hr to form chelates. For the synthesized fertilizer which contain macro nutrients (N, P, K, Ca, Mg), urea, KOH, KH_2PO_4, $CaCl_2$ and $MgSO_4.7H_2O$ were applied as a source of macronutrients before micronutrients salts applying. For the synthesized fertilizer which contain just macro nutrients (NPK)، after hydrolysis completion, urea, KOH and KH_2PO_4 were added. The obtained results indicated that wastes of agriculture like tomatoes or sugar beet straw can be used through hydrolyzing it as a source of amino acids (protein hydrolysate that known as amino acids liquid) that mixed with micro and macronutrients and could be applied to the growing plants. In this concern fertilizers prepared from tomato wastes are somewhat enriched in their contents of amino acids than those from sugar beet wastes, and both of them contain 17 amino acids. Of the highest amino acids concentration were aspartic, glycine and glutamic acids.

Keywords: Agricultural wastes, Tomato and sugar beet straw, Synthetic organic fertilizers, Amino acids.

Annually, Egypt cultivates around 361896 feddan of sugar beet as a winter crop and about 505823 feddan of tomatoes. Sugar beet as an example produces about 5.7 million tons of vegetable wastes yearly (Bulletin of Estimates Agricltural Income, 2011). Also, the quantity of solid waste is estimated at 69-77 Million tons/ year including agricultural wastes which reaches 25-30 Million tons/ year (36-39 %) (Nefisa, 2008). In addition, Anu (2010) indicated that in developing countries, about 50% of wastes are not collected and remains scattered around poor areas causing health problems, land degradation, pollution, and water resource contamination.

Gov.UK. (2012) reported that recycling farm waste can benefit in reducing the risk of pollution, decreasing the amount of wastes going to landfill and saving money.

So, as raw materials, biomass wastes have attractive potentials for large-scale industries and community-level enterprises. Biomass takes the form of residual stalks, straw, leaves, roots, husk, nut or seed shells, waste wood and animal husbandry waste. Widely available, renewable and virtually free, waste biomass is an important resource (UNEP, 2009).

On the other hand, micronutrients are mostly applied to plants by adding in the soil or foliar application to the leaves. When these are applied as mineral salts above pH 6, iron (Fe) and above pH 7, manganese (Mn), boron (B), copper (Cu) and zinc (Zn) are converted into insoluble forms, so their absorption is decreased. The foliar fertilizers, which have an inorganic mineral structure, hardly diffuse from the leaf surface into the plant because of high weight molecular structure (Goos *et al*., 2000). Recently, interest in using alternative mineral sources, particularly those chelated with precursors like citric acid, ethylene diaminetetraacetic acid (EDTA), … etc has increased due to their reportedly higher availability compared to inorganic sources. But high costs restrict the use of synthetic precursors (Koksal *et al*., 1999). Since amino acids are the basic building blocks of proteins found in all living things, the chelation of minerals with amino acids provides a tremendous advantage in increasing the efficiency of absorption and translocation of minerals within plants (Hsu, 1986).

Today, many companies that specialize in amino acids manufacturing produced from agricultural wastes which made a lot of compounds based on amino acids supplemented with micro and macro nutrients. At the commercial level, Albion Lab. (2011) produces metalosare zinc that is derived from a complex of soluble salt with partially hydrolyzed vegetable protein. Also, Exports (2003) is an establishment that focuses to promote and provide solutions to organic farming through the production of bio-pesticides, organic fertilizers and micro-nutrients. Ajinomoto Company (2013) indicated that amino acids are produced through the fermentation of raw materials such as sugarcane. To reduce environmental impact, Ajinomoto has established bio cycle systems that return byproducts generated during the production process to the field of agriculture.

Thus, the present investigation aims to study the recycling of some agricultural wastes such as tomato and sugar beet vegetable parts (straw) which represent the main wastes of field and vegetables crops to produce different organic fertilizers.

Material and methods

Tomato and sugar beet straw were used in this study. Their chemical analysis are shown in Table 1.

TABLE 1. Some chemical composition of tomato and sugar beet straw.

Property	Tomato straw	Sugar beet straw
Organic matter, %	81.4	70.2
Organic carbon, %	47.32	40.82
Total nitrogen, %	2.8	2.5
C/N ratio	17:1	16:1
Protein, %	17.6	15.8
Hemi-cellulose, %	14.78	12.44
Cellulose, %	8.19	14.24
Lignin, %	6.42	3.6
Macronutrients, %		
Phosphorus	0.2	0.27
Potassium	1.95	4.42
Calcium	3.84	0.42
Magnesium	0.89	0.39
Micronutrients, Mg g-1		
Copper	27.92	9.02
Iron	3162	1234
Zinc	29	19.83
Manganese	105.9	50.75

The chemical analyses of agricultural wastes were performed to official methods of AOAC (2006). Organic carbon and organic matter were determined according to Page *et al*., 1982

Preparation of organic synthesized fertilizers (amino acids liquid) from tomato and sugar beet straw with acid hydrolysis

Laboratory trials were done at the laboratories of Regional Center for Food and Feed, Agricultural Research Center, Giza, Egypt to produce different organic fertilizers from tomato and sugar beet straw.

Six amino acids synthesized fertilizers from tomato and sugar beet straw were prepared as follows:

Tomato straw were brought from the Horticulture Research Station, Qanater, Qalubiah Gov. and sugar beet straw were brought from Giza Research Station then they were air dried at ambient temperature for 3 days.

Steps of preparation:

1. One kg of tomato or sugar beet straw were cut, dried for 24 hr at 65^oC in an air oven and ground.
2. Hundred grams of the dried ground tomato or sugar beet straw were transferred to 1L dark brown glass bottle with screw cap lid and to it 300 mL of 6M H_2SO_4 solution were added.
3. The bottle was transferred into an air oven and kept there for 24 hr at 105^oC so the amino acids liquids were prepared according to Jie *et al.* (2008).
4. KOH was added to the amino acids liquid to maintain its pH at 3-4 and to be a source of potassium as macronutrient.

A. Preparation of fertilizer containing K and micro elements (Fe, Mn, Zn, Cu, B)

After hydrolysis completion of tomato or sugar beet straw as mentioned above in the first three steps where the source of amino acids was obtained, 221.77 g of KOH pellets were added slowly and portion wise while cooling and shaking. For chelation of micronutrients, their salts, *i.e.*, zinc sulfate ($ZnSO_4.7H_2O$), iron sulfate ($FeSO_4.7H_2O$), copper sulfate ($CuSO_4.5H_2O$) and manganese sulfate ($MnSO_4.3H_2O$) were used. Fifteen grams of each $MnSO_4.3H_2O$, $CuSO_4.5H_2O$, $ZnSO_4.7H_2O$ and boric acid as well as 5 g $FeSO_4.7H_2O$ were separately dissolved in 20 ml of distilled water then added portion wise to the previous mixture while cooling and shaking. These quantity of micronutrients salts were calculated to reach to the minimum micronutrients contents (2%), percentage weight of fluid fertilizer according to Official Journal the European Union (2003), then the whole mixture was diluted to 1L with distilled water while cooling and shaking. The mixture was then kept on shaker for 4 hr to form chelates (Datir *et al.*, 2010). The synthesized fertilizer was kept at room temperature overnight. The obtained fertilizers were coded by ($T_{A.A.-K-Mic.}$) from tomato straw and ($S_{A.A.-K-Mic.}$) from sugar beet straw.

B. Preparation of fertilizer containing N, P and K

Hundred grams of each of the dried titled waste material was weighed and transferred to 1L dark brown glass with screw cap lid and to it 300 ml 6 M H_2SO_4 were added. This bottle was transferred to an air oven and left overnight at 105^oC for 24 hr. After removing the bottle from the oven it was cooled at room temperature and then transferred to an ice water bath and cooled to 0-5^oC, then to it was added portion wise while cooling and shaking, each of 150 g urea, 221.77 g of KOH and 100 g KH_2PO_4 that these quantity of macronutrients were calculated to reach to the minimum macronutrients contents (3% N, 5% P_2O_5 and 5% K_2O) according to Official Journal of the European Union (2003), then these contents were finally diluted portion wise while cooling and shaking to 1L. The obtained fertilizers were coded by ($T_{A.A.\text{-}NPK}$) from tomato straw and ($S_{A.A.\text{-} NPK}$) from sugar beet straw.

C. Preparation of fertilizer containing macro and micro elements (N, P, K, Ca, Mg, Fe, Mn, Zn, Cu, B)

To prepare the titled fertilizer all the steps of the previous fertilizer was done, but before dilution to 1L, each of 10 g $CaCl_2$, 15 g boric acid, 15 g $MnSO_4.3H_2O$, 5 g $FeSO_4.7H_2O$, 15 g $CuSO_4.5H_2O$, 15 g $ZnSO_4.7H_2O$, 5 g $MgSO_4.7H_2O$ were dissolved separately in 20 mL distilled water. The fertilizer container was diluted with distilled water to 1L final volume then the container was shaken for 4 hr to form chelates and left at room temperature overnight. The obtained fertilizers were coded by ($T_{A.A.\text{-Mac.-Mic.}}$) and ($S_{A.A\ \text{-Mac.-Mic.}}$) from tomato and sugar beet straw, separately.

At the end of preparating synthesized fertilizers from tomato and/or sugar beet straw, their contents of nutrients were determined [nitrogen was estimated by semi-micro kieldahl method of Page *et al*. (1982), P, K, Fe, Mn, Zn, Cu and B using atomic absorption spectrophotometer “Perkin Elmer 3300” according to AOAC (2006). Amino acids contents and curves (Fig.1) were determined using amino acid analyzer equipment (EZChrom) as described by AOAC (2006).

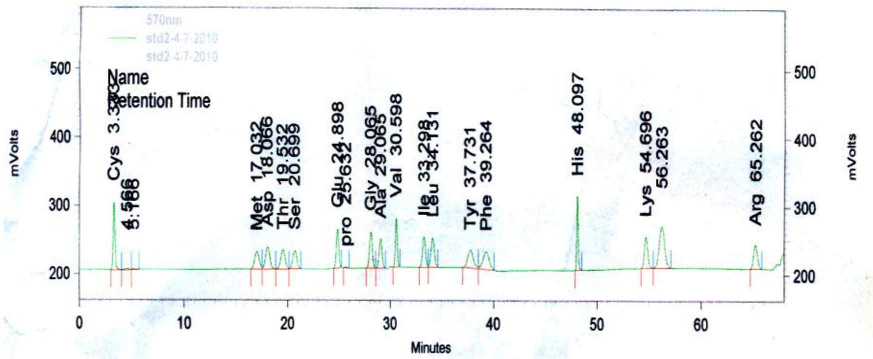

Fig. 1. Chromatogram of standard amino acids by amino acid analyzer equipment (EZChrom).

Results and Discussion

In this study, six products of synthetic organic fertilizers were prepared and optimized. Each fertilizer contained macro and/or micro elements as well as 17 amino acids and can be arranged in descending order concerning their total amino acids contents as 1836, 1700, 1633, 1614, 1579 and 1366 mg/100 mL in $T_{A.A.\text{-Mac.-Mic.}}$, $T_{A.A.\text{-NPK}}$, $S_{A.A.\text{-NPK}}$ & $T_{A.A.\text{-K-Mic.}}$, $S_{A.A.\text{-Mac.-Mic.}}$ and $S_{A.A.\text{-K-Mic.}}$, respectively. (Tables 2-7 and Fig. 2-7).

As mentioned before, agro-industrial residues can be used for soil nutrient recycling and improvement purposes and may therefore be displacing significant quantities of synthetic fertilizers like amino acids or other products.

On the other hand, the requirement of amino acids in essential qualities increases yield and overall quality of crops. The amino acids application for foliar use is based on its requirement by plants in general and at critical stages of growth in particular. Plants can absorb it through stomas. Amino acids are applied also to plants by incorporating them into the soil which can improve the micro flora of the soil, thereby facilitating the assimilation of nutrients. Wastes of Agriculture like tomatoes or sugar beet straw are available in Egypt in huge amounts which can be used by hydrolyzing them as a source of amino acids (protein hydrolysate that known as amino acids liquid) mixed with micronutrients when added to some crops grown on new reclaimed soils.

Chemical characteristics of organic synthesized fertilizers from tomato straw:

Fertilizer no.1 coded by ($T_{A.A.-K-Mic.}$)
pH = 3.76
pH in spray solution= 6.44

TABLE 2. Composition of organic synthesized fertilizer ($T_{A.A.-K-Mic.}$) .

Fertilizer components	Concentration,%	Source	
K_2O	20.7	Potassium hydroxide	
Fe	0.33	Iron sulfate	
Mn	0.55	Manganese sulfate	
Cu	0.59	Copper sulfate	
Zn	0.45	Zinc sulfate	
B	0.35	boric acid	
Amino acids			
Amino Acid	**Concentration, mg/100 mL**	**Amino Acid**	**Concentration, mg/100 mL**
Argenine (ARG)	77.9	Cysetine (CYS)	66.9
Aspartic acid (ASP)	151.9	Valine (VAL)	106.3
Alanine (ALA)	108.7	Phenylalanine (PHE)	82.6
Isoleucine (ILE)	96.4	Lysine (LYS)	100.2
Proline (PRO)	95.2	Leucine (LEU)	105.6
Therionine (THR)	83.9	Methionine (MET)	59.92
Glutamic acid (GLU)	146.6	Histidine (HIS)	71.9
Glycine (GLY)	111.1	Tyrosine (TYR)	60.9
Serine (SER)	87.5	----------------------	-------------
Total amino acids	1614 mg/100 mL		

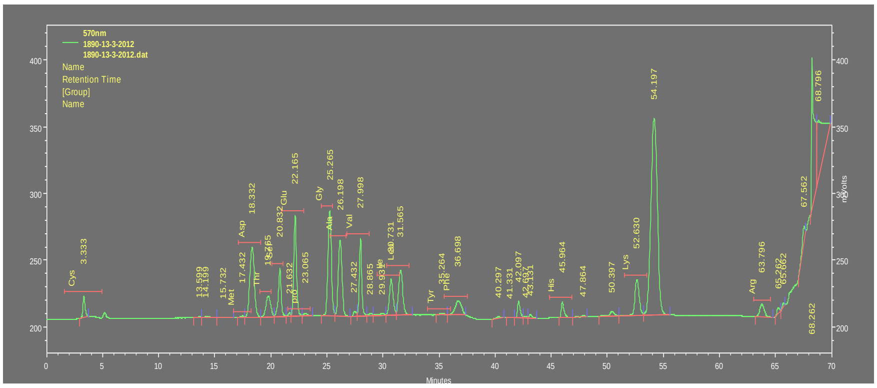

Fig . 2. Chromatogram of amino acids in organic fertilizer coded by ($T_{A.A.\text{-}K\text{-}Mic.}$).

Fertilizer no.2 coded by ($T_{A.A.\text{-} NPK}$)
pH= 3.95
pH in spray solution= 6.48

TABLE 3. Composition of organic synthesized fertilizer ($T_{A.A.\text{-}NPK}$).

	Concentration,%	**Source**	
N	7.30	Urea	
P_2O_5	12.1	Monopotassium phosphate	
K_2O	24.7	Potassium hydroxide & Monopotassium phosphate	
Amino acids			
Amino Acid	**Concentration, mg/100 mL**	**Amino Acid**	**Concentration, mg/100 mL**
Argenine (ARG)	78	Cysetine (CYS)	68.2
Aspartic acid (ASP)	176.8	Valine (VAL)	106.4
Alanine (ALA)	101.8	Phenylalanine (PHE)	90.3
Isoleucine (ILE)	96.4	Lysine (LYS)	95.3
Proline (PRO)	98.7	Leucine (LEU)	115.1
Therionine (THR)	89	Methionine (MET)	61
Glutamic acid (GLU)	177.8	Histidine (HIS)	78.7
Glycine (GLY)	105.4	Tyrosine (TYR)	64.64
Serine (SER)	96.1	----------------------	-------------
Total amino acids	1700 mg/100 mL		

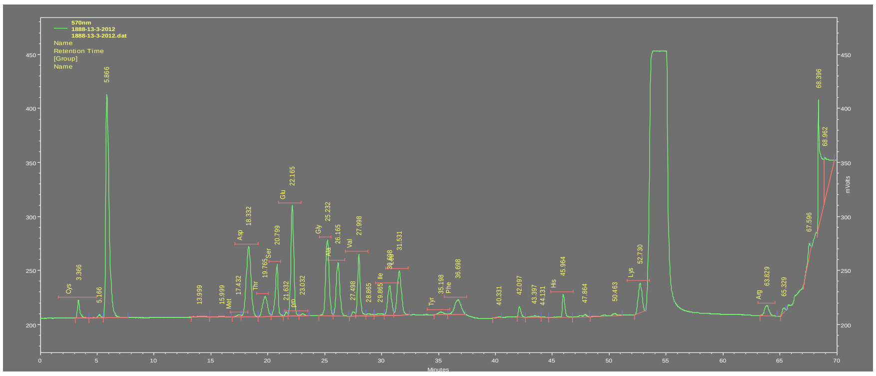

Fig. 3 Chromatogram of amino acids in organic fertilizer coded by ($T_{A.A.\text{-}NPK}$).

Fertilizer no.3 coded by ($T_{A.A.\text{-}Mac.\text{-}Mic.}$)
pH = 4.03
pH in spray solution= 6.48

TABLE 4. Composition of organic synthesized fertilizer ($T_{A.A.\text{-}Mac.\text{-}Mic.}$).

Fertilizer components	Concentration,%	Source
N	7.30	Urea
P_2O_5	11.5	Monopotassium phosphate
K_2O	24.1	Potassium hydroxide & Monopotassium phosphate
Ca	2.10	Calcium chloride
Mg	0.23	Magnesium sulphate
Fe	0.47	Iron sulfate
Mn	0.56	Manganese sulfate
Cu	0.53	Copper sulfate
Zn	0.45	Zinc sulfate
B	0.37	boric acid

Amino acids

Amino Acid	Concentration, mg/100 mL	Amino Acid	Concentration, mg/100 mL
Argenine (ARG)	87.4	Cysetine (CYS)	73
Aspartic acid (ASP)	194.8	Valine (VAL)	113.9
Alanine (ALA)	114.9	Phenylalanine (PHE)	95.4
Isoleucine (ILE)	104	Lysine (LYS)	101.9
Proline (PRO)	108.3	Leucine (LEU)	124.3
Therionine (THR)	95.3	Methionine (MET)	61.2
Glutamic acid (GLU)	191.8	Histidine (HIS)	78.6
Glycine (GLY)	124.5	Tyrosine (TYR)	64.06
Serine (SER)	103	----------------------	-------------
Total amino acids	1836 mg/100 mL		

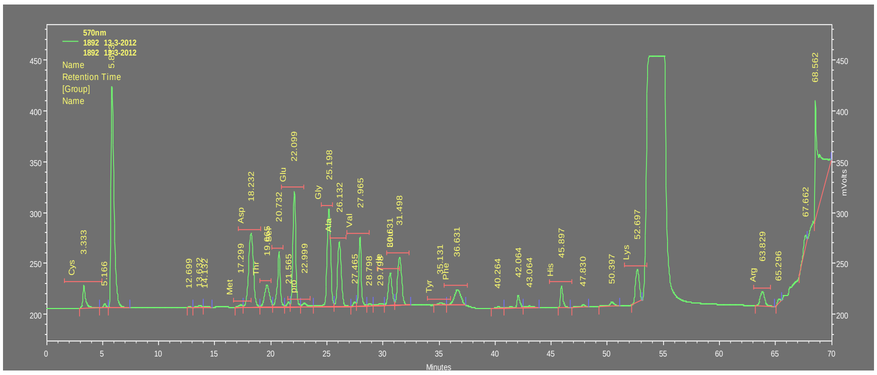

Fig .4. Chromatogram of amino acids in organic fertilizer coded by ($T_{A.A.-Mac.-Mic.}$).

Chemical characteristics of organic synthesized fertilizers from sugar beet straw:

Fertilizer no.4 coded by ($S_{A.A.-K-Mic.}$)
pH = 3.33
pH in spray solution= 6.25

TABLE 5. Composition of organic synthesized fertilizer ($S_{A.A.-K-Mic.}$).

Fertilizer components		Concentration,%	Source
K_2O		21.0	Potassium hydroxide
Fe		0.34	Iron sulfate
Mn		0.46	Manganese sulfate
Cu		0.48	Copper sulfate
Zn		0.37	Zinc sulfate
B		0.41	boric acid
Amino acids			
Amino Acid	**Concentration, mg/100 mL**	**Amino Acid**	**Concentration, mg/100 mL**
Argenine (ARG)	70.8	Cysetine (CYS)	65.1
Aspartic acid (ASP)	98.8	Valine (VAL)	89.2
Alanine (ALA)	86.3	Phenylalanine (PHE)	73.2
Isoleucine (ILE)	80.6	Lysine (LYS)	79
Proline (PRO)	81	Leucine (LEU)	84.9
Therionine (THR)	75.1	Methionine (MET)	58.8
Glutamic acid (GLU)	114.4	Histidine (HIS)	68.41
Glycine (GLY)	102	Tyrosine (TYR)	60.03
Serine (SER)	78	----------------------	-------------
Total amino acids	1366 mg/100 mL		

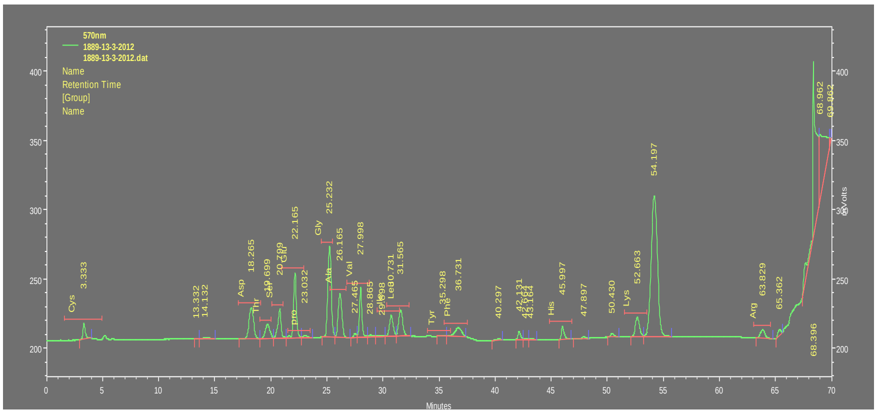

Fig .5. Chromatogram of amino acids in organic fertilizer coded by ($S_{A.A.-K-Mic.}$).

Fertilizer no.5 coded by ($S_{A.A.-\ NPK}$)
pH= 4.06
pH in spray solution= 6.47

TABLE 6. Composition of organic synthesized fertilizer ($S_{A.A.-NPK}$).

Fertilizer components	Concentration,%	Source
N	7.25	Urea
P_2O_5	12.1	Monopotassium phosphate
K_2O	25.1	Potassium hydroxide & Monopotassium phosphate

Amino acids

Amino Acid	Concentration, mg/100 mL	Amino Acid	Concentration, mg/100 mL
Argenine (ARG)	81.2	Cysetine (CYS)	69.2
Aspartic acid (ASP)	131	Valine (VAL)	105.5
Alanine (ALA)	100.8	Phenylalanine (PHE)	88.3
Isoleucine (ILE)	93.7	Lysine (LYS)	84.8
Proline (PRO)	96.8	Leucine (LEU)	109.4
Therionine (THR)	88.6	Methionine (MET)	59.6
Glutamic acid (GLU)	164.8	Histidine (HIS)	81
Glycine (GLY)	122.2	Tyrosine (TYR)	63.9
Serine (SER)	92.3	----------------------	-------------
Total amino acids	1633 mg/100 mL		

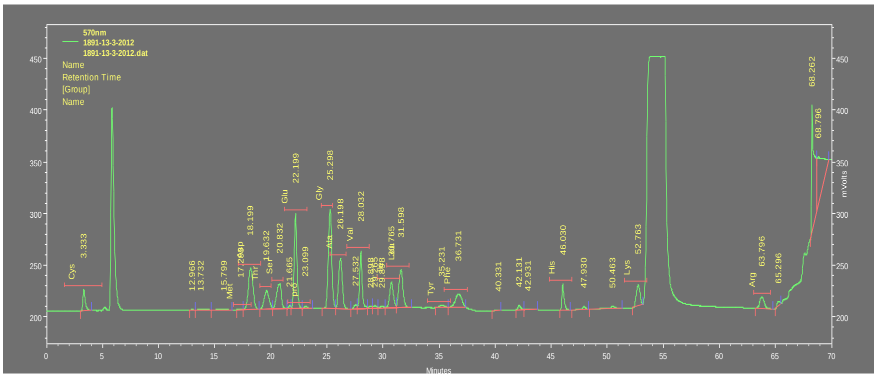

Fig . 6. Chromatogram of amino acids in organic fertilizer coded by ($S_{A.A.-NPK}$).

Fertilizer no.6 coded by ($S_{A.A.-Mac.-Mic.}$)
pH = 3.68
pH in spray solution= 6.23

TABLE 7. Composition of organic synthesized fertilizer ($S_{A.A.-Mac.-Mic.}$).

Fertilizer components	Concentration,%	Source
N	7.40	Urea
P_2O_5	12.1	Monopotassium phosphate
K_2O	24.8	Potassium hydroxide & Monopotassium phosphate
Ca	2.50	Calcium chloride
Mg	0.20	Magnesium sulphate
Fe	0.56	Iron sulfate
Mn	0.54	Manganese sulfate
Cu	0.52	Copper sulfate
Zn	0.41	Zinc sulfate
B	0.40	boric acid

Amino acids			
Amino Acid	**Concentration, mg/100 mL**	**Amino Acid**	**Concentration, mg/100 mL**
Argenine (ARG)	81.8	Cysetine (CYS)	72
Aspartic acid (ASP)	123.3	Valine (VAL)	100
Alanine (ALA)	98.4	Phenylalanine (PHE)	84.1
Isoleucine (ILE)	94.9	Lysine (LYS)	83.7
Proline (PRO)	94.9	Leucine (LEU)	102.3
Therionine (THR)	86.7	Methionine (MET)	58.8
Glutamic acid (GLU)	144.1	Histidine (HIS)	78.3
Glycine (GLY)	121.3	Tyrosine (TYR)	64.16
Serine (SER)	90.2	----------------------	-------------
Total amino acids	1579 mg/100 mL		

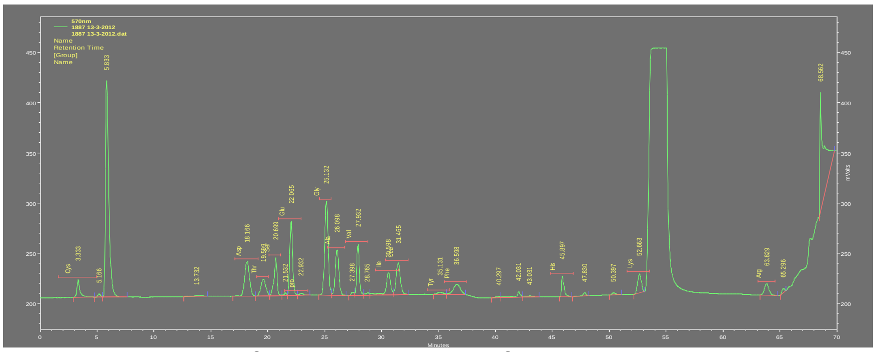

Fig. 7. Chromatogram of amino acids in organic fertilizer coded by ($S_{A.A.-Mac.-Mic.}$).

These results suggest that tomatoes wastes are higher in their contents (mg/100 ml) of amino acids than sugar beet wastes and the highest amino acids of all synthesized fertilizers were Aspartic acid (ASP), Glutamic acid (GLU), Glycine (GLY), Leucine (LEU) and Valine (VAL), respectively. Amino Acids have a chelating effect on micronutrients when applied together The absorption and transportation of micronutrients inside the plant is easier. This effect is due to the chelating action and to the effect of cell membrane permiability. Glycine and Glutamic Acids are known to be very effective chelating agents. Proline act mainly on the hydric balance of the plant strengthening the cellular walls in such a way that they increase resistance to unfavourable climatic conditions.

In this respect, Jie *et al*. (2008) indicated that amino acid chelated micronutrient fertilizers by hydrolyzation of chicken waste feather foliar application cause an increase in growth parameters from 22 – 73% of rice over the control and increase in chlorophyll contents by 11–17 %, therefore when amino acid chelated micronutrient fertilizer is used in small amounts has a low cost and high rates of return. Abdel– Mawgoud *et al*. (2011) found that foliar application of amino acids and micronutrient enhances performance of green bean crop under newly reclaimed conditions.

These six organic synthesized fertilizers were tested biologically on the growth and yield of pearl millet (*Pennisetum americanum*) as well as sorghum (*Sorghum vulgare*) and their effect on soil properties are under publication by Mostafa *et al*. (2013).

Conclusion

Wastes of agriculture like tomatoes or sugar beet straw are available in Egypt in huge amounts which can be used to hydrolyzing it as a source of amino acids (protein hydrolysate that known as amino acids liquid) and mixed with micro and macronutrients to improve the growth and yields of crops grown on treated soils. In this concern tomato wastes are somewhat enriched in their contents of amino acids than sugar beet wastes and both of them contain 17 amino acids. Of the highest amino acids concentration were glycine and glutamic acids which are known to be very effective chelating agents.

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(*Received* 8 /5/ 2013;
accepted 5 /6 / 2013)

تصنيع أسمدة تحتوي علي أحماض أمينية من المخلفات الزراعية . 1- استخدام عروش الطماطم وبنجر السكر لتحضير أسمدة عضوية

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أستخدمت بعض المخلفات الزراعية مثل عروش الطماطم وبنجر السكر كمصادر أساسية لتحضير الأسمدة العضوية المحتوية على أحماض أمينية حيث تم إجراء تجارب معملية بالمركز الاقليمى للأغذية والأعلاف بمركز البحوث الزراعية بالجيزة لإنتاج ستة أسمدة من عروش الطماطم وبنجر السكر بواسطة التحلل المائي الحامضى باستخدام حمض الكبريتيك (6 مولر) بنسبة 1 : 3 من عروش الطماطم أو بنجر السكر: حمض الكبريتيك تحت درجة حرارة 105° م لمدة 24 ساعة ولخلب العناصر الصغرى تم خلط أملاحها (كبريتات زنك، كبريتات حديد، كبريتات نحاس، كبريتات منجنيز) بالإضافة إلي حمض البوريك مع الأحماض الأمينية حيث تم اذابة هذة الأملاح منفصلة في 20 ملليمتر من الماء المقطر ثم تكملة الحجم النهائى للمحلول إلي واحد لتر ثم وضع المحلول علي هزاز لمدة 4 ساعات لتكوين المركبات المخلبية بينما فى الأسمدة المخلقة المحتوية على عناصر كبرى تم إضافة اليوريا وفوسفات البوتاسيوم الأحادى وهيدروكسيد البوتاسيوم وكلوريد الكالسيوم وكبريتات الماغنسيوم كمصدر لعناصر النيتروجين، الفوسفور، البوتاسيوم، الكالسيوم و الماغنسيوم وذلك بالاضافة لأملاح العناصر الصغرى.

أثبتت التحاليل ان الأسمدة المحضرة من عروش الطماطم غنية فى محتواها من الأحماض الأمينية مقارنة بتلك المحضرة من عروش بنجر السكر وقد أحتوى كل منها على 17 حمض أمينى وكان أعلاهم فى التركيز أحماض الجليسين والجلوتاميك والأسبارتيك.