J. Plant Production, Mansoura Univ., Vol. 7(1): 1 - 6, 2016

RESPONSE OF GARLIC PLANTS TO FOLIAR APPLICATION OF MORINGA LEAVES EXTRACT, GLUTAMINE AND CYSTEINE

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ABSTRACT

Foliar application with some amino acids provides plant with readymade nutrition, thus it has positive effect on plants metabolism with a corresponding promotion in crop quantity and quality. Thus, two field experiments were conducted at Kaha Vegetable Research Farm, Qalubia governorate, Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 in a clayey loamy soil under flood irrigation system. Garlic (*Allium sativum* L.) cv. Sids 40 was used to study the effect of foliar application with three concentrations of each, moringa leaves extract (5, 10 and 15 g/ L), glutamine (50, 100 and 200 ppm) or cysteine (50, 100 and 200 ppm) on growth, yield, quality and gloves oil content. Gloves were planting at mid of September in both seasons. A Randomized Complete Block Design with three replications was used.

The obtained results revealed that foliar spray with moringa leaves extract 10 g/ L, glutamine 200 ppm or cysteine 100 ppm treatments gave the highest values of plant growth criteria i.e. plant length, number of leaves/ plant, leaves chlorophyll content and leaves area of garlic at both seasons as compared to the other treatments and control. Concerning yield and yield components, spraying with moringa leaves extract 10 g/ L, glutamine 200 ppm or cysteine 100 ppm increased curing yield (ton/ fed.) by (59.4 %, 60.1 % and 59.2 %) and (42.1 %, 42.9 % and 41.9 %) and blubs dry matter % by (10.5 %, 11.7 % and 11.2 %) and (10.6 %, 10.1 % and 10.6 %) over the control, in the first and second seasons, respectively. Also, using the same above mentioned treatments were the best and gave significant increases of bulb quality (average cured bulb diameter and weight), chemical constitutes: K (%) and P (%,) total free amino acids (g/ 100 g dry weigh) and essential oil (mg/ kg dry weight).

Results of the present work highlighted the positive effect of moringa leaves extract as natural substance and as it can mimic the role of synthetic amino acids, it could be applied safely (as plant foliar spray) for preserve human health and environment.

Keywords: Garlic, moringa leaves extract, free amino acids, glutamine, cysteine, vegetative growth, yield, quality.

INTRODUCTION

The recognized health benefits and the potency of garlic have been highlighted in many publications. Garlic (*Allium sativum* L.) is a perennial plant of the family Alliaceae and it is one of the most commonly used vegetable in cooking for its flavor. Garlic is a strongly aromatic bulb that has been used for long time in medicine because it contains sulfur active compounds in the form of cysteine derivatives, also it possesses antidiabetic, antibiotic and various other biological actions and thus makes this herb as an important source of therapeutic agents (Augusti, 1996).

Plants can synthesize amino acids from the primary elements by means of photosynthesis. The requirement of amino acids is essential and is well know means to increase yield and improve overall quality of crops. The application of amino acids for foliar use is based on its type in general and its concentration in particular to avoid off target spray. Amino acids are involved in the synthesis of many organic compounds, such as protein, amines, alkaloids, enzymes, vitamins, terpenoids (Ibrahim *et al*., 2010). Several investigators worked in improving garlic yield and quality by applying different amino acids as foliar spray at different growth stages. In this concern, Fawzy *et al*. (2012) and Shalaby and El-Ramady (2014) stated that foliar application of amino acids significant improved garlic vegetative growth and bulb weight and hence effectively increased yield and its quality.

Perspective of sustainable crop production and increasing agricultural yield with little and cheap inputs are the demands for farmers especially small scales one. This includes novel agricultural practices such as plant foliar spray with substances of a natural origin that do not harm the environment and that support and sustain local communities. One of those natural substances which can be applied safely to crops is moringa leaves extract. *Moringa oleifer* (miracle tree) has an impressive benefits and wide range of uses due to its high nutritional value. The moringa plant is loaded with nutrients such as antioxidants, vitamins, minerals, phytonutrients, and proteins. Accordingly, many scientists highlighted the role of its leaves extract (as crop foliar application) in enhancing different crop production. Some authors recorded significant enhanced by moringa foliar application on growth criteria (plant height, fresh and dry weight) and yield of rocket, pea and onion (Abdalla, 2013; Mishra *et al*., 2013 and Mohammed *et al*., 2013), respectively.

Therefore, this study was conducted to evaluate the effect of moringa leaves ethyl alcohol extract or two amino acids (glutamine and cysteine) foliar application on growth, yield and quality of garlic plants.

MATERIALS AND METHODS

The experiment was conducted at Kaha Vegetable Research Farm, Qalubia governorate, Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 in a clayey loamy soil under flood irrigation system. Garlic cloves (*Allium sativum* L.) cv. Sids 40 applied to study the effect of foliar application with three concentrations of each moringa leaves extract (5, 10 and 15 g/ L), glutamine (50, 100 and 200 ppm) or cysteine (50, 100 and 200 ppm) on growth, yield, quality and gloves oil content of garlic. The spray was applied three times during the cultivation season; the first was after two months from sowing and then two times one month interval.

Preparation of moringa leaves extract

Air dried leaves of *Moringa oleifera* were grinded then 100 g of moringa leaves powder were soaked in 1 L ethyl alcohol (80%) for 4 h on a rotary shaker in order to maximize extraction. The extract was filtered twice through Whatman filter paper no.1 then ethyl alcohol was evaporated under vacuum using rotary evaporator. The residue of the extract was dissolved in 100 ml distilled water in the presence of tween twenty 1% to make stock solution. Some chemical constituents of moringa leaves ethyl alcohol extract were determined by Rady and Mohamed (2015) as shown in Table (1).

Table 1: Some chemical constituents of moringa leaves extract on dry weigh (DW) basis.

Component	**Value (mg/g DW)**
Amino acids	124.7
Proline	26.09
Total soluble sugars	151.4
Ash	111.3
calcium	8.756
Magnesium	6.035
Potassium	27.68
Phosphorus	6.122
Sodium	0.674
Iron	1.873
Manganese	0.966
Zinc	0.453
Copper	0.208
Solubule phenols	2.252
Total carotenoids	2.243
Total chlorophyll	4.625
Ascorbic acid	3.247
Phytohormones	**Value (µg/g DW)**
Indole 3 acetic acid	0.873
Gibberellins	0.802
Zeatin	0.936
Abscisic acid	0.292

Both amino acids (glutamine and cysteine) were obtained as commercial chemical substances from El-Gomhorya Company (Egypt).

Gloves were planting at mid of September in both seasons. A Randomized Complete Block Design with three replications was used. The plot area was 9.6 m^2 which contains 4 rows. Each row was 4 m long and 0.6 m wide. Cloves were planted 20 cm apart in both sides of each row. Other agricultural practices were carried out as recommended for the conventional garlic planting.

The experiment included 10 treatments as follows

1- Moringa leaves extract 5 g/ L
2- Moringa leaves extract 10 g/ L
3- Moringa leaves extract 15 g/ L
4- Glutamine 50 ppm
5- Glutamine 100 ppm
6- Glutamine 200 ppm
7- cysteine 50 ppm
8- cysteine 100 ppm
9- cysteine 200 ppm
10- Control(spray with water)

Measurements

A- Vegetative growth

Five plants were taken randomly from each plot after 150 days from planting to record the average of following data:

1. Plant length (cm)
2. Number of leaves/plant
3. Leaves chlorophyll content *
4. leaves area/ plant

* Determination of chlorophyll was done by using Minolta chlorophyll meter SPAD- 502 as SPAD units.

B- Total Yield and bulbs dry matter %

1. Fresh total yield (ton/ fed.) was determined at harvest.
2. Cured yield (ton/ fed.), plants were cured for 21 days after harvest.
3. Dry matter % of cured bulbs.

C- Bulb quality

After curing, 10 bulbs from each plot were taken to record:

1. Average bulb diameter (cm)
2. Average bulb weight (g)
3. Average number of cloves/ bulb
4. Clove weight (g)

D- Chemical analysis of cloves

Phosphorus and potassium percentage in the dry matter of cured bulbs were determined according to the methods described by Murphy and Riley (1962) and Brown and Lilleland (1946), respectively. The method used for estimation total free amino acids was described by El-Araby (1987). The percentage of volatile oil in garlic gloves (calculated as dry weight) determined by hydro-distillation using a Clevenger-type apparatus according to Guenther (1961).

Statistical analysis of data

Data were subjected to analysis of variance method according to Snedecor and Cochran (1980). The comparisons of treatment means were done with Duncan Multiple Range Test (Duncan, 1955). All data analyses were performed using the *STATISTIX* version 8.0 software.

RESULTS AND DISCUSSION

Vegetative growth

All data of vegetative growth presented in Table (2) indicated that the spraying with each of moringa leaves extract, glutamine and cysteine treatments caused significant increases in plant growth criteria; plant

length, number of leaves/ plant, leaf chlorophyll content and leaf area of garlic at both seasons except chlorophyll content recorded non-significant in second season. Moringa leaves extract 10 g/ L, glutamine 200 ppm or cysteine 100 pp treatments gave the highest values of plant growth criteria at both seasons as compared to the other treatments and control. Generally we can notice that there is a linear relationship between the glutamine concentration and the recorded data i.e. the third concentration recorded the best results. However, such effect was changed when using moringa extract or cysteine where the increment continued gradually up to the second concentration used (10 g/ L or 100 ppm, respectively) then decrease with the third concentration (15 g/ L or 200 ppm, respectively).

Table 2. Vegetative growth of garlic (Sids 40) as affected by foliar spray of moringa leaves extract, glutamine and cysteine during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Plant length (cm)		Leaves number /plant		Leaves chlorophyll content (SPAD)		leaves area /plant (cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Morang 5 g/ L	64.33cd	68.66c	10.3bc	11.0bc	70.3c	70.7a	353.5c	315.6d
Morang 10 g/ L	81.66a	83.66a	12.0a	12.0a	75.1a	73.5a	386.0a	375.0ab
Morang 15 g/ L	74.00b	75.33b	10.3bc	11.3abc	74.2ab	73.5a	371.1b	373.5ab
Glutamine 50 ppm	67.33c	73.00bc	11.0abc	11.6ab	71.0bc	71.0a	338.0d	311.3d
Glutamine100ppm	80.00a	83.33a	11.3ab	11.6ab	71.3bc	71.8a	357.0c	345.9c
Glutamine200ppm	82.00a	85.66a	12.0a	12.0a	75.1a	72.9a	385.0a	375.3ab
Cysteine 50 ppm	66.66c	71.33bc	10.6bc	11.3abc	72.7abc	72.6a	315.3e	311.7d
Cysteine 100 ppm	81.66a	85.33a	12.0a	12.0a	75.2a	73.3a	385.0a	376.0a
Cysteine 200 ppm	80.66a	84.00a	11.3ab	11.3abc	72.7abc	72.9a	375.3b	369.0b
Control	60.33d	63.00d	10.0c	10.6c	69.7c	69.4a	296.3f	236.0e

Means within the same column followed by the same letters are not significantly different at 5% according to Duncan's Multiple Range Test

The reason for this enhancement may be due to that, amino acids affect directly or indirectly the physiological processes of the plant, where it increase chlorophyll content in the leaves and activate the vital physiological processes within the plant, leading to increased plant growth rate (Boras *et al*., 2011). Cytokinins, present in moringa leaves extract, enhance food production as they are involved in cell growth and differentiation, and their exogenous supply delays senescence of crop plants.

Many studies reported that the foliar application of amino acids caused an enhancement effect on plant growth on tomato (Boras *et al*., 2011) and on potato (Al-Hamdany and Mohammed, 2014). Using putrescine (50, 100 and 200 ppm) as a chemical growth regulator or moringa leaves extract (3.5%, 7% and 10%) as a natural extract have positive effect on growth and photosynthetic pigments (Chlorophyll a, b and carotenoids) of jojoba plants (Taha *et al*., 2015).

Total yield and bulbs dry matter %

All foliar spray and their concentrations affected yield components of garlic positively (Table 3). Moringa leaves extract 10 g/ L, glutamine 200 ppm or cysteine 100 ppm were the best treatments and gave significant increases of fresh total yield (ton/ fed.) by (64.9%, 67.8% and 67.6%), and (27.7%, 29.1% and 28.0%), curing yield (ton/ fed.) by (59.4 %, 60.1 % and 59.2 %) and (42.1 %, 42.9 % and 41.9 %) and blubs dry matter % by (10.5 %, 11.7 % and 11.2 %) and (10.6 %, 10.1 % and 10.6 %) over the control in the first and second season, respectively. For the most stated parameters in Table (3) the second concentration of moringa extract (10 g/ L) and cysteine (100 ppm) proved to be better than the other two corresponding concentrations, while the third concentration of glutamine was the best comparing with other concentrations.

Amino acids are the main structure of protein which involves in plant metabolic activities and provides plants with basic materials for healthy and vigorous vegetative growth (Table 2) which may reflect on total yield. Positive response of garlic and onion plants to foliar application with different levels of amino acids was studied by El-Shabasi *et al*. (2005) and Shafeek *et al*. (2012), respectively.

Extract from fresh moringa leaves can be used to produce an effective plant growth hormone, increasing yield be 25- 30 % for different crops (Fuglie, 2000). In addition, aqueous extract of moringa was reported to improve sesame growth and grain yield per unit area because of it plays a key role as a plant growth hormone (Muhamman and Mohammed, 2014). Also Mvumi *et al*. (2013) found that *Moringa oleifera* leaves extract applied on common beans leaves increased yield in field trials.

Bulb quality

This study showed that spraying with amino acids and moringa leaves extract had a positive and significant effect on average cured bulb diameter and weight. Spraying with moringa leaf extract 10 g/ L, glutamine 200 ppm or cysteine 100 ppm increased average cured bulb diameter and weight (Table 4) compared with control in the two seasons. Thus those measured traits may be the reflection of the increment in total yield (Table 3). The maximum average number of cloves/ bulb was produced in control while, the minimum average number of cloves/ bulb recorded

when spraying with moringa leaves extract 10 g/ L, glutamine 200 ppm or cysteine 100 in both seasons. The increment in bulb diameter and bulb weight and the decrease in number of cloves/ bulb led to an increment in clove weight, and this is a preferable trait in the market.

Table 3. Total yield and bulbs dry matter % of garlic (Sids 40) as affected by foliar spray of moringa leaves extract, glutamine and cysteine during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Fresh total yield ton/ fed.		Cured yield ton/ fed.		Bulbs dry matter %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Moringa 5 g/ L	7.370f	6.566cd	6.604e	6.053c	43.8c	43.9d
Moringa 10 g/ L	11.360a	8.235a	10.237a	7.797a	47.4a	47.0a
Moringa 15 g/ L	9.725c	7.327b	8.026c	6.696b	45.2b	44.6bcd
Glutamine 50 ppm	7.762e	6.716c	6.744e	5.885c	44.3c	44.3cd
Glutamine 100ppm	10.950b	8.230a	9.770b	7.653a	45.5b	45.3bc
Glutamine 200ppm	11.557a	8.324a	10.274a	7.837a	47.9a	46.8a
Cysteine 50 ppm	8.186d	6.742c	7.347d	5.860c	45.2b	44.5bcd
Cysteine 100 ppm	11.543a	8.253a	10.229a	7.787a	47.7a	47.0a
Cysteine 200 ppm	10.837b	8.187a	9.516b	7.589a	45.6b	45.5b
Control	6.887g	6.447d	6.424e	5.486c	42.9d	42.5e

Means within the same column followed by the same letters are not significantly different at 5% according to Duncan's Multiple Range Test.

Table 4. Cured bulb characters of garlic (Sids 40) as affected by foliar spray of moringa leaves extract, glutamine and cysteine during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Bulb diameter (cm)		Bulb weight (g)		Cloves number /bulb		Clove weight (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Moringa 5 g/ L	5.90e	5.82bc	72.1d	64.4c	17.6a	16.3ab	4.10c	3.95de
Moringa 10 g/ L	6.63a	6.50a	80.1ab	77.3a	15.5c	14.6d	5.17a	5.29ab
Moringa 15 g/ L	6.12c	6.40a	75.3cd	71.7b	16.8ab	15.7bc	4.48b	4.57c
Glutamine 50 ppm	5.93de	5.84bc	73.6cd	65.2c	17.2a	16.2ab	4.28b	4.02d
Glutamine 100ppm	6.36b	6.43a	76.3bc	76.3a	17.6a	16.3ab	4.34b	4.68c
Glutamine 200ppm	6.65a	6.53a	80.2a	78.6a	15.5c	14.8d	5.17a	5.31a
Cysteine 50 ppm	6.07cd	6.01b	73.6cd	65.8c	17.4a	16.1abc	4.23bc	4.09d
Cysteine 100 ppm	6.64a	6.56a	80.0ab	78.4a	15.4c	14.7d	5.19a	5.33a
Cysteine 200 ppm	6.36b	6.43a	77.0abc	76.5a	15.6bc	15.3cd	4.94a	5.00b
Control	5.82e	5.733c	61.6e	61.5d	17.9a	16.8a	3.44d	3.66e

Means within the same column followed by the same letters are not significantly different at 5% according to Duncan's Multiple Range Test

According to Sarojnee *et al*. (2009), amino acids can increase uptake of nutrients and water, enhance the photosynthetic rate and dry matter partitioning and hence increase yield and quality of crops. Amin *et al*. (2011) and Shafeek *et al*. (2012) recorded that foliar application of some amino acids either alone or in combination, significantly increased bulb length, bulb diameter and weight, as well as yield of onion and quality of bulbs. Foliar spray of garlic plants with mixture of alanine, arginine, cysteine and glycine (each at 100 ppm) scored higher value of bulb diameter while, 100 ppm cysteine was the most effective treatment for producing better garlic bulbs weight (El-Shabasi *et al*., 2005).

Chemical analysis of bulbs

Data presented in Table (5) indicated that the same treatment concentrations (moringa leaves extract 10 g/ L, glutamine 200 ppm or cysteine 100) which recorded better results for the yield also reflect positively on chemical content i.e. phosphorous %, potassium %, total free amino acids (mg/ 100 g dry weight) and volatile oil (ml/ kg dry weight) of garlic blubs. The other two concentrations of both amino acids and moringa leaves extract were less effective but still better than control in the two studied seasons.

In the present work, as the plant cell is filled with solutes (increasing P % and K %) the plant will take up water, create cell turgidity, decrease solute leakage and hence keep plants upright and vigorous. An enhancement in squash seeds NPK content by using moringa leaves extract as foliar spray, at different concentrations: 2, 4 and 6 g/ L, was observed by Hegazi *et al*. (2015).

Yunsheng *et al*. (2015) found that using glutamine at 25 ppm increased total free amino acids in snap bean leaves, while 100 ppm increased it in pods. Gamal El-Din and Abd El-Wahed (2005) recorded an increase in essential oil percentage, in particular the valuable components as α-bisabolol oxide A, of chamomile by foliar spray with three amino acids (ornithine, proline and phenylalanine) at different concentrations (0, 50, 100, 150 mg/ L).

Table 5. Chemical analysis of garlic (Sids 40) as affected by foliar spray of moringa leaves extract, glutamine and cysteine during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Phosphorus %		Potassium %		Total free amino acids mg/ 100 g dry weight		Volatile oil ml/ kg dry weight	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Moringa 5 g/ L	0.350cde	0.353cd	1.33de	1.31c	577.0d	519.3ef	0.364cd	0.367cd
Moringa 10 g/ L	0.403a	0.400a	1.41ab	1.41a	692.3a	649.6a	0.425a	0.432a
Moringa 15 g/ L	0.360bcd	0.356c	1.34d	1.32c	633.6c	537.0de	0.371bc	0.383b
Glutamine 50 ppm	0.336de	0.343de	1.30ef	1.30c	632.0c	562.0c	0.373bc	0.370c
Glutamine 100ppm	0.363bc	0.353cd	1.37c	1.35b	672.3b	594.0b	0.375bc	0.371c
Glutamine 200ppm	0.400a	0.406a	1.43a	1.42a	690.6a	649.6a	0.427a	0.433a
Cysteine 50 ppm	0.370bc	0.376b	1.37c	1.35b	634.0c	553.6cd	0.376b	0.371c
Cysteine 100 ppm	0.400a	0.403a	1.43a	1.42a	693.6a	655.3a	0.420a	0.424a
Cysteine 200 ppm	0.380ab	0.383b	1.38bc	1.36b	636.6c	569.0c	0.372bc	0.372bc
Control	0.326e	0.336e	1.28f	1.28d	547.6e	507.3f	0.359d	0.356d

Means within the same column followed by the same letters are not significantly different at 5% according to Duncan's Multiple Range Test

CONCLUSION

Data of this experiment highlighted the positive effect of moringa leaves extract as natural substance at a concentration of 10 g/ L on growth, yield, quality and bulbs oil content of garlic. Also, applying glutamine 200 ppm and cysteine 100 ppm as synthetic amino acids gave the same enhancements for above mentioned traits.

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إستجابة نباتات الثوم للرش الورقى بمستخلص أوراق المورينجا، الجلوتامين و السيستين

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الرش الورقي للنباتات ببعض الأحماض الأمينية يمد النباتات بالتغذية الجاهزة، وبالتالي فإنه له أثر إيجابي على التمثيل الغذائى والذى يصاحبه جودة المحصول كماً وكيفاً. ولذلك تم إجراء تجربة حقلية في المزرعة البحثية بقها (محافظة القليوبية) بمصر خلال موسمى الشتاء ٢٠١٣/٢٠١٤ و٢٠١٤/٢٠١٥ فى أرض طميية طينية تحت نظام الرى بالغمر. تم إستخدام الثوم صنف سدس ٤٠ لدراسة تأثير الرش الورقى بثلاث تركيزات من كل من مستخلص أوراق المورينجا (٥، ١٠، ١٥ جرام فى اللتر) أو الجلوتامين (٥٠، ١٠٠، ٢٠٠ جزء فى المليون) أو السستين (٥٠، ١٠٠، ٢٠٠ جزء فى المليون) على النمو والمحصول وجودة الفصوص ومحتواها من الزيت الطيار. تم زراعة الفصوص فى منتصف سبتمبر فى كلا الموسمين. و كان تصميم التجربة القطاعات الكاملة العشوائية فى ثلاث مكررات.

أظهرت النتائج أن الرش بمستخلص أوراق المورينجا ١٠ جرام فى اللتر أو الجلوتامين ٢٠٠ جزء فى المليون أو السستين ١٠٠ جزء فى المليون أعطى أفضل النتائج لصفات نمو النبات: أي طول النبات، عدد الأوراق/ نبات، ومحتوى الأوراق من الكلوروفيل ومساحة الأوراق للثوم في كلا الموسمين بالمقارنة مع المعاملات الأخرى والكنترول. وبالنسبة للمحصول ومكوناته فإن الرش بمستخلص أوراق المورينجا ١٠جرام فى اللتر أو الجلوتامين ٢٠٠ جزء فى المليون أو السستين ١٠٠جزء فى المليون زادت المحصول المعالج (طن للفدان) ب (٥٩,٤ %، ٦٠,١ %، ٥٩,٢ %) و (٤٢,١ % ، ٤٢,٩ % ، ٤١,٩ %) ونسبة المادة الجافة فى الرؤوس ب (١٠,٥ % ، ١١,٧ % ، ١١,٢ %)و (١٠,٦ % ، ١٠,١ % ، ١٠,٦ %) عن الكنترول فى الموسم الأول و الموسم الثانى على التوالى. أيضا إستخدام نفس المعاملات المذكورة أعلاه أدى إلى زيادة معنوية لجودة الرؤوس (متوسط قطر ووزن الرأس بعد العلاج التجفيفى) ومحتواها الكيمائى من: الفسفور(%) والبوتاسيوم (%) والأحماض الأمينية الحرة (جرام/ ١٠٠جرام وزن جاف) و الزيت الطيار (ملليجرام/ كيلوجرام وزن جاف).

نتائج هذا العمل ألقت الضوء على الأثر الإيجابي لمستخلص أوراق المورينجا كمادة طبيعية يمكن أن تحاكي دور الأحماض الأمينية الإصطناعية، ولذلك يمكن إستخدامها بأمان (كرش ورقى للنباتات) حفاظاً على صحة الإنسان والبيئة.