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Research Article
Physiological Effect of Aqueous Seed Extract of Fenugreek on Productivity and Grain Quality of Wheat Plant

Mona Gergis Dawood, Kowther Gad Ali El-Rorkiek, Mohamed El-Sayed El-Awadi and Mervat Shamon Sadak

Department of Botany, National Research Centre, Dokki, 12622, Cairo, Egypt

Abstract

Background and Objective: A worldwide effort to reduce the amount of chemical substances used in crop production by introducing modern biological methods. One of the possible solutions is allelopathy that involves both inhibitory and stimulatory biochemical interactions between plants. So, this work aimed to study the physiological effect of aqueous seed extract of fenugreek on productivity and grain quality of wheat plant. **Materials and Methods:** A field experiment was carried out at the experimental station of National Research Centre, Nubaria district El-Behera Governorate, Egypt, during two winter seasons of 2016/2017 and 2017/2018 to investigate the physiological effect of aqueous seed extract of fenugreek (5, 10 and 15%) on two wheat cultivars (Gimeza 7 and Sakha 94) grown under sandy soil conditions. **Results:** All aqueous seed extract of fenugreek (5, 10 and 15%) showed significant positive effect on growth parameters, photosynthetic pigments, grains yield, yield components and some biochemical constituents of the yielded grains of both wheat cultivars. The results revealed that 10% aqueous seed extract of fenugreek caused the maximum significant increases in the most of investigated parameters. Since, 10% aqueous extract of fenugreek significantly increased total photosynthetic pigments by 32.10% in Gimeza 7 cv. (cultivar) and by 33.42% in Sakha 94 cv. and increased grains yield of Gimeza 7 cv. by 36.36% and Sakha 94 cv. by 28.73%. **Conclusion:** Aqueous extract of fenugreek seed could be used in improving performance of wheat plant grown under sandy soil condition.

Key words: *Trigonella foenum-graecum* L., *Triticum aestivum* L., sandy soil, allelochemicals, grains quality

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Corresponding Author: Mona Gergis Dawood, Department of Botany, National Research Centre, Dokki, 12622, Cairo, Egypt

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the important cereal crops in Egypt and many other countries in the third world. There is an extreme shortage in wheat production; such problem appears to be growing rather than diminishing or even stabilizing due to the increase of population rate and the huge loss of agriculture soils due to desertification and erosion problems. Therefore, extending wheat growing outside the Nile Valley is the first effort toward overcoming wheat problems. The sandy soils in Egypt as a part of the Sahara Desert of Northern Africa, is exposed to a combination of environmental stress conditions including low water availability, high irradiances, temperature fluctuations, soil salinity and nutrients deprivation. In this concern, great efforts must be paid to increase plant tolerance to such conditions via selecting tolerant genotypes and applying the optimum cultural practices and/or treating the seeds (before sowing) or plants (at different growth stages) with some regulating substances that play an important role in helping plants to overcome partially the un-favorable conditions and avoid their negative effects on yield quantity and quality.

In agriculture, there is a worldwide effort to reduce the amount of chemical substances used in crop production by introducing modern biological and ecological methods. One of the possible solutions is allelopathy that involves both inhibitory and stimulatory biochemical interactions between plants (crops, trees, shrubs and weeds)[1]. Most allelochemicals are classified as secondary metabolites that are produced from shoots of the primary metabolic pathways of the plants. Allelochemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates and amino acids. Sometimes the mixture of different compounds exerts greater allelopathic effect than individual compound alone. Allelochemicals may be selective in their action or plants may be selective in their responses[2]. Allelochemicals which inhibited the growth of some species at certain concentrations may stimulate the growth of same or different species at different concentrations[3]. Allelochemicals once released are short lived in the environment and therefore, do not disastrously upset the balance as the chemicals would do. Target processes of allelochemicals are germination of pollen, production of plant hormones and their balance, cell division, membrane stability, permeability, mineral uptake, pigment synthesis, photosynthesis, movement of stomata, respiration, nitrogen fixation, amino acid synthesis, specific enzyme activities and conductive tissue[4]. There is no common mode of action or physiological target site for all allelochemicals. As the allelopathic effects are both positive and negative, both of these effects can be utilized for higher production. Negative (stimulatory) allelopathic effects of any weed or crops can be utilized to develop ecofriendly, cheap and effective green growth promoters. Similarly, the positive (inhibitory) allelopathic effects of any weed or crops on weeds can be utilized to develop green herbicides[5].

Plant extracts should be considered as a secure alternative to chemical fertilizer[6]. In the present time, researchers are looking for the natural alternatives that have similar impact to the chemical compound and protect the environment from pollution. There are several plants that can be used such as; natural extracts for foliar application on plant, either the extract from the whole plant or parts of it, which has important effect on the growth and development of plants.

Fenugreek (*Trigonella foenum-graecum* L.) belonging to the Leguminosae family and widely grown in Egypt and Middle Eastern countries. The most effective part of the plant is the seeds that contains a group of naturally occurring chemical compounds as alkaloids which contain mostly basic nitrogen atoms, including choline and trigonelline used in plants metabolism[7,8]. Seeds contain 22% protein, 28% jel materials, 6% fixed oils and saponins materials[9]. Moreover, the seeds of fenugreek contain lysine and L-tryptophan rich proteins, mucilaginous fiber and other rare chemical constituents such as; saponins, coumarin, fenugreekine, nicotinic acid, sapogenins, phytic acid, scopoletin and trigonelline[10]. They added that all extracts of the fenugreek seeds (methanol, ethanol, dichloromethane, acetone, hexane and ethyl acetate) exhibit antioxidant activity because of phenolic acids and flavonoids.

Previous studies showed that foliar application of fenugreek extract improved growth parameters of different plants. Abbas[11] showed that spraying *Lavandulu officinalis* L. with fenugreek seed extract at a concentration of 5 g L^{-1} significantly increased shoot dry weight and total chlorophyll content in leaf tissues. Dawood *et al.*[12] mentioned that fenugreek treatment caused significant increases in the photosynthetic pigments and total carbohydrate content of sunflower leaves accompanied by a significant decrease in the total phenolic content. Moreover, fenugreek treatment is the most effective treatment in increasing oil (%) and caused the highest decrease in C16:0+C18:0 accompanied by the highest increase in C18:1+C18:2. Lazim *et al.*[13] explained that spraying snapdragons (*Antirrhinum majus*) plant with the fenugreek seeds extract at a concentration of 2 g L^{-1} significantly increased plant height, number of branches and flowers per plant. Abbass *et al.*[14] showed that spraying Snapdragon with fenugreek seed extract at a concentration of 6 g L^{-1} significantly increased growth parameters of plant

height, number of leaves, shoot dry weight, total content of chlorophyll and total soluble carbohydrates in leaves. Furthermore, intercropping fenugreek with faba bean can reduce *Orobanche crenata* infection[15].

The aim of this work was to investigate the effect of foliar spraying of wheat plant grown under sandy soil conditions with aqueous seed extract of fenugreek at 5, 10 and 15% as natural substances.

MATERIALS AND METHODS

Experimental procedure: A field experiment was carried out at the experimental station of National Research Centre, Nubaria district El-Behera Governorate, Egypt, during two winter season of 2016/2017 and 2017/2018. Wheat grains cultivars (Gimeza 7 and Sakha 94) were obtained from Agricultural Research Centre Giza, Egypt. The experimental design was a complete randomized block design with four replicates. Wheat grains were sown on the 15th November in both season in rows 3.5 m long and the distance between rows was 20 cm apart, plot area was 10.5 m^2 (3.0 m in width and 3.5 m in length). The recommended agricultural practices of growing wheat grain were applied and the seeding rate was 60 kg grains/fed. Pre-sowing, 150 kg/fed of calcium super-phosphate (15.5% P_2O_5) was applied to the soil. Nitrogen was applied after emergence in the form of ammonium nitrate 33.5% at rate of 75 kg/fed was applied at five equal doses before the 1st, 2nd, 3rd, 4th and 5th irrigation. Potassium sulphate (48.52% K_2O) was added at two equal doses of 50 kg/fed, before the 1st and 3rd irrigations. Wheat plants were sprayed twice after 45 and 60 days from sowing with aqueous extract of seeds.

Data recorded: Plant samples were collected after 75 days from sowing for recording growth characters in terms of shoot height (cm), number of leaves/plant as well as plant fresh and dry weight (g). Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) in fresh leaves were determined as method recommended by Moran[16].

At harvest, the following characters were recorded on random samples of 10 plants in each treatment: spike length, spike weight, spikelet number/spike, grains weight/spike, 1000 grains weight, straw yield, biological yield and grains yield.

Biochemical analysis: Total carbohydrates were determined calorimetrically according to the method of DuBois *et al.*[17]. Phenolic compounds were determined by using Folin and Ciocalteu phenol reagent as described by Makkar *et al.*[18]. Total flavonoid contents were measured by the aluminum chloride colorimetric assay as described by Ordonez *et al.*[19]. The free radical scavenging activity was determined according to Brand-Williams *et al.*[20] using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) reagent.

Statistical analysis: Data were statistically analyzed at 5% probability according to Snedecor and Cochran[21].

RESULTS AND DISCUSSION

Vegetative growth parameters: Table 1 showed significant variations in vegetative growth parameters (shoot height, number of leaves/plant as well as plant fresh and dry weight) between two wheat cultivars (Gimeza 7 and Sakha 94), when grown under sandy soil conditions. All aqueous seed extract of fenugreek (5, 10 and 15%) showed significant enhancement effect on all vegetative growth parameters of both wheat cultivars. It was obvious that aqueous extract of fenugreek at 10% caused the maximum significant increases of all vegetative growth parameters.

These results are in line with those obtained by previous studies that documented improving growth parameters of

Table 1: Effect of aqueous seed extract of fenugreek on vegetative growth parameters of two wheat cultivars

Treatments	Shoot height (cm)	Number of leaves/plant	Plant fresh weight (g)	Plant dry weight (g)
Gimeza 7 cv.				
Control	62.18	4.44	4.46	1.69
Fenugreek 5%	74.88	4.64	6.10	1.94
Fenugreek 10%	80.20	4.84	7.35	2.30
Fenugreek 15%	75.26	5.00	7.11	2.14
Sakha 94 cv.				
Control	58.20	4.34	4.21	0.86
Fenugreek 5%	74.60	5.10	5.88	1.59
Fenugreek 10%	76.66	5.18	6.25	1.82
Fenugreek 15%	75.02	4.80	5.00	0.92
LSD at 5%	1.52	0.26	0.09	0.07

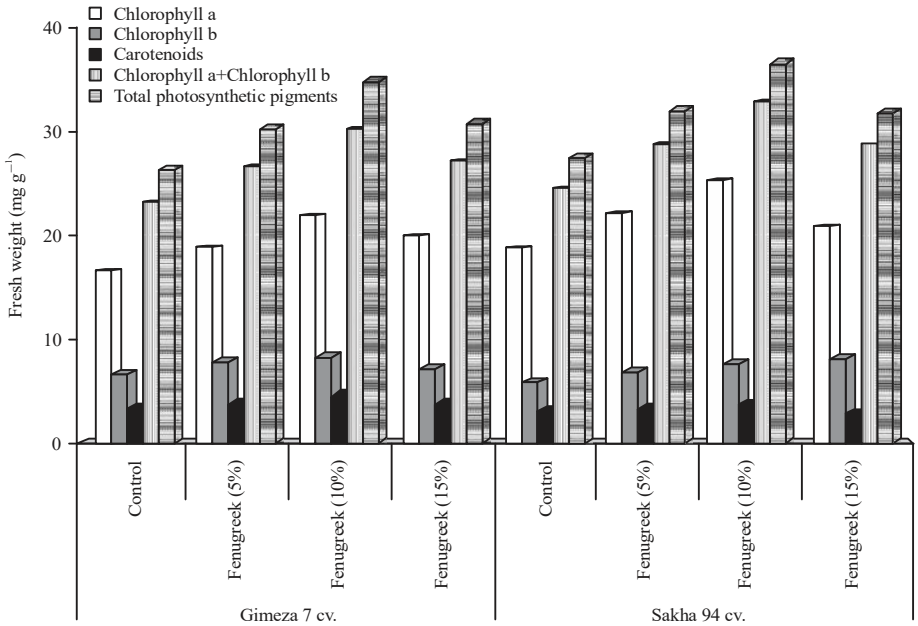

Fig. 1: Effect of aqueous seed extract of fenugreek treatments on photosynthetic pigments of two wheat cultivars

Table 2: Effect of aqueous seed extract of fenugreek on yield and yield components of two wheat cultivars

Treatments	Spike length (cm)	Spike weight (g)	Number of spikeletes/spike	Grains weight /spike (g)	Weight of 1000 grains (g)	Straw yield (t/fed)	Biological yield (t/fed)	Grains yield (Ardabe/fed)
Gimeza 7 cv.								
Control	7.60	1.79	17.0	1.77	35.15	3.12	4.82	11.55
Fenugreek 5%	8.40	2.19	19.5	1.99	41.143	3.32	5.94	14.64
Fenugreek 10%	11.00	2.54	21.8	2.27	43.07	4.48	6.75	15.75
Fenugreek 15%	10.50	2.25	20.6	2.18	42.65	3.82	6.04	14.80
Sakha 94 cv.								
Control	8.00	1.41	18.0	1.51	33.31	2.61	4.58	12.60
Fenugreek 5%	10.40	1.93	20.5	2.05	35.94	3.49	6.04	15.66
Fenugreek 10%	11.50	2.32	21.5	2.06	37.99	4.44	6.90	16.22
Fenugreek 15%	10.40	2.24	20.5	1.82	38.39	3.27	5.55	14.90
LSD at 5%	0.91	0.13	0.96	0.07	0.39	0.07	0.13	0.53

different plants by foliar application of fenugreek extract. Abbass *et al.*[14] as well as Lazim *et al.*[13] showed that spraying *Lavandulu officinalis* L. and snapdragons (*Antirrhinum Majus*) plants with fenugreek seed extract significantly increased some growth parameters.

Photosynthetic pigments: Figure 1 showed the response of photosynthetic pigment of wheat leaf tissues to different concentrations of aqueous seed extract of fenugreek (5, 10 and 15%). The results showed that all treatments led to significant increases in photosynthetic pigments of two wheat cultivars (Gimeza 7 and Sakha 94) when compared to the corresponding controls. The maximum significant increases of the photosynthetic pigments of both cultivars were achieved by foliar application with 10% aqueous seed extract fenugreek. These enhancements in photosynthetic pigments of both cultivars may be explained as reported by Abu-Dhahi and Al younis[22], who mentioned that fenugreek seeds extract including important nutrients, as iron element that positively affects photosynthesis and chlorophyll building. These results are in agreement with those observed by Abbas[11], who showed that spraying *Lavandulu officinalis* L. with fenugreek seed extract at a concentration of 5 g L^{-1} significantly increased total chlorophyll content in leaf tissues. Dawood *et al.*[12] mentioned that fenugreek treatment caused significant increases in the photosynthetic pigments and total carbohydrate content of sunflower leaves. Moreover, Abbass *et al.*[14] showed that spraying with fenugreek seed extract at a concentration 6 g L^{-1} significantly increased total content of chlorophyll and total soluble carbohydrates in leaves.

Grains yield and yield components: Data in Table 2 showed the response of grains yield and yield components of two

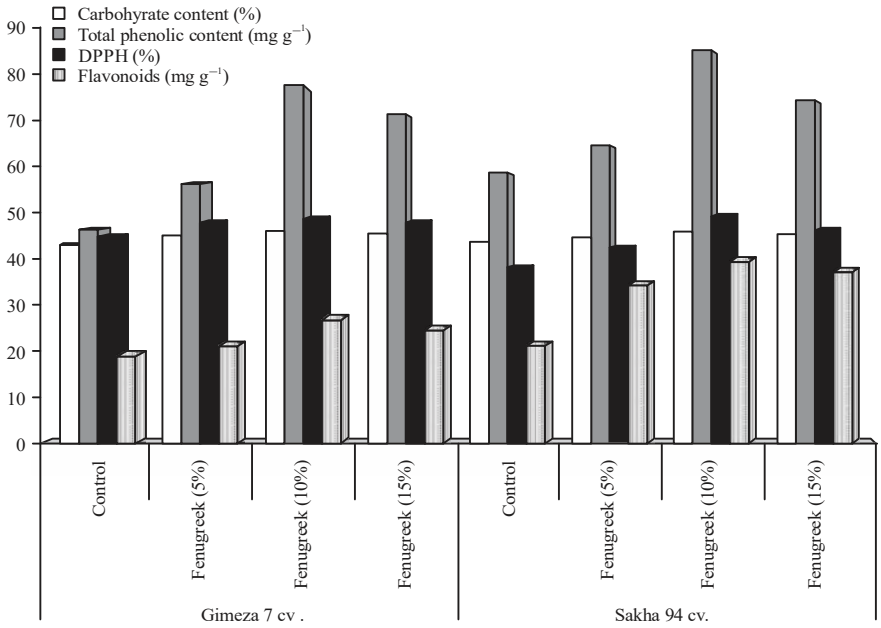

Fig. 2: Effect of aqueous extract of fenugreek on some biochemical constituents of two wheat cultivars

wheat cultivars sprayed with different concentrations of aqueous seed extract of fenugreek (5, 10 and 15%). The results showed that treated plants with the different concentrations led to significant increases in grain yield and yield components (Spike length, spike weight, number of spikelet/spike, grains weight/spike, weight of 1000 grains, straw yield, biological yield and grain yield) of two wheat cultivars (Gimeza 7 and Sakha 94) when compared to the corresponding controls. The maximum significant increases of the grains yield and yield components of both cultivars were achieved by foliar application with 10% aqueous seed extract of fenugreek. It was noted that Sakha 94 cv. was characterized by higher grains yield than Gimeza 7 at all treatments. About 10% aqueous seed extract of fenugreek increased grains yield of Gimeza 7 cv. by 15.75% and Sakha 94 cv. by 16.22%.

These enhancements in grains yield and yield components may be explained by the finding of Abu Dhahi and Al Yunis[22], who mentioned that fenugreek seeds extract including important nutrients, as iron element that positively affects photosynthesis and chlorophyll building which leads to an increase of food manufacturer in the plant and in turn, may contribute to the operations of cell division and increases in the number of leaves and branches. Likewise, Mengel and Kirkby[23] stated that potassium (K) in the fenugreek seeds extract plays an important role in enzyme activation and increase in carbohydrate accumulation as well as cells division thereby resulting in high plant growth and yield.

Biochemical constituents of two wheat cultivars: Figure 2 showed significant variations in content of some biochemical constituents (phenolic content, flavonoids and antioxidant activity by DPPH) between two wheat cultivars (Gimeza 7 and Sakha 94) when grown under sandy soil conditions. All aqueous seed extract of fenugreek (5, 10 and 15%) showed significant enhancement effect on biochemical (phenolic content, flavonoids and antioxidant activity) of both wheat cultivars. Meanwhile, 10% aqueous seed extract of fenugreek significantly increased carbohydrate content. It was obvious that aqueous seed extract of fenugreek at 10% caused the maximum significant increases, whereas, aqueous extract of fenugreek at 5% caused the lowest increase in biochemical constituents of both cultivars.

The increases in carbohydrate content was previously explained by Devlin and Witham[24], who stated that aqueous seed extract of fenugreek containing important nutrients as potassium that played a role in increasing cell division and its relationship to the representation of nucleic acids Zinc as cofactors in oxidative process in plant cells and this is very important in regulating sugar consumption and also an important role in biological processes in the plant. Its shares in the formation of starch, which in the ends increase the content of plant carbohydrates. These results are in good agreements with those reported by Dawood *et al.*[12], who mentioned that fenugreek treatment caused significant increases in the total carbohydrate content of sunflower leaves.

CONCLUSION

All aqueous seed extract of fenugreek (5, 10 and 15%) showed significant positive effect on growth parameters, photosynthetic pigments, grains yield, yield components and some biochemical constituents of the yielded grains of both wheat cultivars. The results revealed that 10% aqueous seed extract of fenugreek caused the maximum significant increases in the most of investigated parameters. Since, 10% aqueous extract of fenugreek significantly increased total photosynthetic pigments by 32.10% in Gimeza 7 cv. and by 33.42% in Sakha 94 cv. and increased grains yield of Gimeza 7 cv. by 15.75% and Sakha 94 cv. by 16.22%.

SIGNIFICANCE STATEMENT

This study discovers that the aqueous seed extract of fenugreek (5, 10 and 15%) have beneficial role for improving quality and quantity of wheat plants. This study will help the researcher to uncover the critical areas of using natural extract that many researchers were not able to explore.

REFERENCES

1. El-Khawas, S.A. and M.M. Shehata, 2005. The allelopathic potentialities of *Acacia nilotica* and *Eucalyptus rostrata* on monocot (*Zea mays* L.) and Dicot (*Phaseolus vulgaris* L.) plants. Biotechnology, 4: 23-34.
2. Einhellig, F.A., 2004. Mode of Allelochemical Action of Phenolic Compounds. In: Allelopathy: Chemistry and Mode of Action of Allelochemicals, Macias, F.A., J.C.G. Galindo, J.M.G. Molinillo and H.G. Cutler (Eds.). CRC Press, Boca Raton, FL., USA., ISBN-13: 9780849319648, pp: 217-238.
3. Narwal, S.S., 1994. Allelopathy in Crop Production. Scientific Publisher, Jodhpur, India, Pages: 288.
4. Wink, M.S., T. Schmeller and B. Latz-Bruning, 1998. Modes of action of allelochemical alkaloids: Interaction with neuroreceptors, DNA and other molecular targets. J. Chem. Ecol., 24: 1881-1937.
5. Oudhia, P., 1999. Studies on allelopathy and medicinal weeds in chickpea fields. Int. Chickpea Pigeonpea Newslett., 6: 29-33.
6. Hasan, A.E., K.M. Bhiah and M.T. Al-Zurfy, 2014. The impact of peat moss and sheep manure compost extracts on marigold (*Calendula officinalis* L.) growth and flowering. J. Org. Syst., 9: 56-62.
7. Newall, C.A., L.A. Anderson and J.D. Phillipson, 1996. Herbal Medicines: A Guide for Health-Care Professional. 1st Edn., The Pharmaceutical Press, London, UK., ISBN-13: 9780853692898, pp: 117-118.
8. Barnes, J., L.A. Anderson and J.D. Phillipson, 2002. Herbal Medicines: A Guide for Healthcare Professionals. 2nd Edn., The Pharmaceutical Press, London, UK., ISBN-13: 9780853694748, Pages: 530.
9. Hussein, F., 1979. Medicinal Plants, Cultivation and Components. Addar Al Arabia Lil Kitab Publisher, Tripoli, Libya, pp: 71-73.
10. Bukhari, S.B., M.I. Bhanger and S. Memon, 2008. Antioxidative activity of extracts from fenugreek seeds (*Trigonella foenum-graecum*). Pak. J. Anal. Environ. Chem., 9: 78-83.
11. Abbas, A.A., 2011. Effect of spraying nitrogen and some plants extracts in the vegetative growth on (*Lavandula officinalis* L). Iraqi J. Vet. Med., 35: 175-184.
12. Dawood, M.G., M.E. El-Awadi and K.G. El-Rokiek, 2012. Physiological impact of fenugreek, guava and lantana on the growth and some chemical parameters of sunflower plants and associated weeds. J. Am. Sci., 8: 166-174.
13. Lazim, Z.S., S.N. Jasim and C.A. Ahmed, 2013. The effect of spraying with both extracts of liquorice and fenugreek invegetative, flowering growth and vase life of *Antirrhinum majus* L. Euphrates J. Agric. Sci., 5: 8-17.
14. Abbass, J.A., M.T. Al-Zurfi, A.A.A. Hassan and S.M. Ali, 2016. Effect of spraying Fenugreek seed extracts *Rigonella foenum-graecum* L. and Salicylic acid on growth and flowering parameters of Snapdragon plant (*Antirrhinum majus* L.). Agric. Sci. Res. J., 6: 101-106.
15. Fernandez-Aparicio, M., A. Andolfi, A. Evidente and D. Rubiales, 2006. Orobanche species specific responses to *Trigonella foenum-graecum* root exudates. Proceedings of the Workshop on Parasitic Plant Management in Sustainable Agriculture Final Meeting of COST849, November 23-24, 2006, Lisbon, Portugal.
16. Moran, R., 1982. Formulae for determination of chlorophyllous pigments extracted with *N,N*-dimethylformamide. Plant Physiol., 69: 1376-1381.
17. DuBois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith, 1956. Colorimetric method for determination of sugars and related substances. Anal. Chem., 28: 350-356.
18. Makkar, H.P.S., K. Becker, H. Abel and E. Pawelzik, 1997. Nutrient contents, rumen protein degradability and antinutritional factors in some colour- and white-flowering cultivars of *Vicia faba* beans. J. Sci. Food Agric., 75: 511-520.
19. Ordonez, A.A.L., J.D. Gomez, M.A. Vattuone and M.I. Lsla, 2006. Antioxidant activities of *Sechium edule* (Jacq.) Swartz extracts. Food Chem., 97: 452-458.
20. Brand-Williams, W., M.E. Cuvelier and C. Berset, 1995. Use of a free radical method to evaluate antioxidant activity. LWT-Food Sci. Technol., 28: 25-30.

21. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Edn., Iowa State University Press, Iowa, USA., ISBN-10: 0813815606, Pages: 507.
22. Abu Dhahi, Y.M. and M.A. Al Yunis, 1988. Plant nutrition guide. Ministry of Higher Education and Scientific Research, University of Mosul, Iraq.
23. Mengel, K. and E.A. Kirkby, 2001. Principles of Plant Nutrition. 5th Edn., Kluwer Academic Publishers, Dordrecht, Netherland, ISBN-13: 9781402000089, Pages: 849.
24. Devlin, R.M. and F.H. Witham, 1992. Plant Physiology (Translated by Abdul-Majid, T.R., F.A. Salh and H.F. Khamis). 2nd Edn., College of Education (Ibn-Al-Haitam), University of Baghdad, Iraq.