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FOLIAR SPRAY OF PEA PLANTS WITH MODIFIED EGG ALBUMIN FOR ENHANCING GROWTH AND PRODUCTIVITY

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ABSTRACT

This work was carried out during the two successive winter seasons of 2015/ 2016 and 2016/2017 under sandy soil conditions using drip irrigation system at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt, to study the effect of different native and modified egg white protein and total amino acids concentrations as foliar applications on growth, antioxidants, yield and seeds chemical constituent of pea cv. Master B. Foliar spraying of pea plants with native egg albumin (NEA) at 2 ml/l increased stem length, number of branches/plant and total fresh weight/ plant in both seasons. Foliar spray with hydrolyzed methylated egg albumin (HMEA) at 2 ml/ l increased the concentration of chlorophyll a, b, and (a+b) and carotenoids compared to other treatments. Multi amino acids 24% (MAA) at 2 ml/ l increased N and total protein, MAA at 1 ml/l increased P(%) and HMEA at 2 ml/l increased K (%) in seeds in both seasons. NEA at 1.5 ml/ l or hydrolyzed native egg albumin (HNEA) at 1 ml/l increased number of green pod/plant, average green pod weight, yield of green pods/ plant and total yield/ green pod, whereas HMEA at 1.5 ml/ l or MAA at 1.5 ml l increased number of seeds/ pod.

Key words: Peas, egg white protein, methylation, protein hydrolysates, yield.

INTRODUCTION

Peas (*Pisum sativum* L.) which belongs to the family Fabaceae is considered the most widely distributed pules in most countries over all the world. It is an excellent source of protein, complex carbohydrates, vitamins (A, B and C), phosphorus, potassium, magnesium, calcium and many other minerals, great nutritional importance due to their high contents of protein, complex carbohydrates, dietary fiber, minerals, vitamins, and antioxidant compounds **(Biesaga-Koscielniak *et al.*, 2014).** Egg white is a normal source of proteins of famed nutritional and biological advantages **(Pihlanto and Korhonen, 2003)**. Enzymatic hydrolysis is a particular technique to transform native protein to protein **(Abdel-Hamid *et al.*, 2016; Osman *et al.*, 2016).** Protein hydrolysates are mix of polypeptides, oligopeptides and amino acids **(Poullain *et al.*, 1989)**. **(Kauffman *et al.*, 2007)** classified organic bio stimulant compounds, into three major groups on the basis of their source and content: humic substances, seaweed extracts, and amino acids containing products. The last group consists of free amino acids and polypeptides obtained through chemical and/or enzymatic hydrolysis of agro industrial by-products from animal or plant sources or from dedicated biomass crops **(Colla *et al.*, 2014).**

Recently, there is a growing apprehension on the utilize of animal-derived protein hydrolysates in terms of food safety as

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elucidated by the ban of animal-derived protein hydrolysate application on the eaten parts of crops in organic cultivation, **Ertani *et al.* (2009) and Gurav and Jadhav (2013)** reported beneficial effects for foliar protein hydrolysates applications on growth, yield and fruit quality of agricultural crops. Protein hydrolysate could also work as plant growth regulators due to the appearance of peptides. Several bioactive peptides generated in a species of plants have been found to have plant hormones-like activities **(Ito *et al.,* 2006; Kondo *et al.,* 2006). Ertani *et al.* (2009)** spotted that uses of plant-derived protein hydrolysates on corn and tomato plants increased value nutrient uptake in particelular nitrogen and iron as a result of increased glutamine synthetase (GS) and nitrate reductase (NR) activities, and Fe (III)-chelate reductase activity, respectively. Two protein hydrolysate based on fertilizers (PHFs) increased leaf growth and root and motivated morphological changes in root architecture. Besides, the treatments increased NR and GS activities, indicating a positive role of the two hydrolysates in the inducement of nitrate transformation into organic nitrogen **(Ertani *et al.*, 2009)**. The root, shoot dry weight, root area, and root length were significantly higher by 35, 21, 26, and 24%, respectively, in tomato treated plants with the protein hydrolysate at 6 ml/l than untreated plants. Increasing the concentration of the protein hydrolysate from 0 to 10 ml/l increased the total dry biomass, SPAD index, and leaf nitrogen content by 20.5, 15, and 21.5%, respectively. So, the use of plant-derived protein hydrolysate contain amino acids and short peptides excited a plant hormone-like activity, augmented nitrogen uptake and consequently crop performances **(Colla *et al.,* 2014)**. Amino acids for the production of bio-stimulants are obtained by chemical synthesis, from plant protein as well as from nimal proteins by chemical or enzymatic hydrolysis **(Popko *et al.*, 2014)**. Amino acids are considered as precursors and constituents of proteins **(Rai, 2002),** which are important for stimulation of cell growth. They contain both acidic and basic groups and work as buffers, which assist to protect appropriate pH value within the plant cell **(Khan *et al.,* 2012**). Also, amino acids is a well-known bio-stimulants which has favorable effects on plant yield, growth and significantly moderates the damage raised by abiotic stresses **(Kowalczyk *et al.,* 2008). El-Zohiri and Asfour (2009)** on potato recordrd that spraying of amino acids (0.25 ml/1) increased vegetative growth expressed as plant height and plant dry weight. Therefore, the objective of the current research was to study the effect of foliar spray with bio-stimulants activity of native and modified (chemically and enzymatically) egg albumin on growth and output of pea plants under sandy soil conditions.

MATERIALS AND METHODS

Experimental Design

This research was carried out during the two successive winter seasons of 2015/ 2016 and 2016/2017 under sandy soil conditions using drip irrigation system at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt, to study the effect of native and modified egg white protein and total amino acids at different concentrations as foliar applications on growth, antioxidants, yield and seeds quality of pea cv. Master B. The physical and chemical properties of experimental soil in the two seasons showed that it was sandy in texture and had 0.07 and 0.08 % organic matter, 8.03 and 8.08 pH, 1.74 and 1.76 mmhos/cm EC, 5.35 and 5.58 ppm available N, 3.54 and 3.48 ppm available P and 9.87 9.83 ppm available K in the 1^{st} and 2^{nd} season, respectively.

This experiment included 16 treatments, which were the different concentrations (1.0, 1.5 and 2.0 ml/l.) of native egg albumin (NEA), hydrolyzed native egg albumin (HNEA), methylated egg albumin (MEA), hydrolyzed methylated egg albumin (HMEA) and total amino acids (24%) as foliar applications as well as control (water). These treatments were arranged in a randomized complete block design with three replications. Seeds were inoculated with Rhizobactrin at 400 g/fad., before sowing. Seeds sown at 5 cm apart, on 5th October in both seasons and Master B cultivar was used in this experiment. The plot area was 12.6 m^2. It contains three dripper lines with 6m length each and 70 cm distance between each two dripper lines. One line was used to measure the morphological and physiological traits and other two lines were used for yield determinations. Plants were sprayed with the different concentrations of native and modified egg white protein and multi amino acids or tap water three time at 10 days intervals beginning 25 days after sowing in both seasons 25, 35 and 45 days after sowing. Each experimental plot received two liter solutions of each concentrations using spreading agent in all treatments to improve adherence of the spray to the plant foliage for increasing egg white protein absorption by the plants. The untreated plants (check) were sprayed with tap water and spreading agent. One dripper line was left between each two experimental plots without spraying as a gourd row to avoid the overlapping of spraying solution.

Substances Preparation

Sample preparation

Fresh hen eggs were collected from the Farm of Poultry Department, Faculty of Agriculture, Zagazig University. Protein extraction was performed basically according to the method reported by **(Omana *et al.*, 2011),** with some modification. Egg white was accurately separated from yolk and softly homogenized with a magnetic stirrer for 30 min to decrease the viscosity. The white homogenate was lyophilized and stored at -20°C until used. SDS–PAGE of protein was performed on a discontinuous buffered system according to **(Laemmli, 1970).** Total amino acids composition of egg white protein was determined by amino acid analyzer apparatus model "Eppendorf LC3000" **(Simpson *et al.*, 1976).**

Protein modification

Lyophilized NEA was subjected to enzymatic modification by papain from *C. papaya* L (Sigma-St. Louis, MO, USA) and chemical modification (esterification reaction with methanol in the presence of HCl). Also, MEA was subjected to chemical modification with methanol.

Chemical modification

The procedure of **(Sitohy *et al.*, 2000)** was utilized for esterifying protein by dispersing a appropriate amount (5% *W/V*) in concentrated methanol (>99.5%). The reaction mix was preserved at 4°C under continued stirring for 10 hr., while adding an amount of HCl equivalent to 50 molar ratio (mole acid/mole -COOH) at the reaction start. The esterification extent of proteins was quantified according to **(Bertrand-Harb *et al.*, 1991)**.

Enzymatic modification

Lyophilized protein (NEA and MEA) was dissolved in 0.1M phosphate buffer pH 6.0 (5%) and hydrolysed by treating with papain (E/S ratio of 1:200 (*W/W*)) at 37°C for 4 hr., and pH 6.0 as described by **(Abdel-Hamid *et al.*, 2016)**. The degree of hydrolysis was assayed according to the method described by **Hoyle and Merrltt (1994)**.

Data Recorded

Plant growth characters

Five plants from each plot were randomly taken at 55 days after sowing and the following data were recorded: Plant growth: Plant height, branch number/plant, number of leaves/plant and total fresh weight/plant.

Leaf pigments: disks sample from the fourth upper leaf was obtained from every experimental unit at 55 days after swing to determine chlorophyll a, b and carotenoids according to the method described by **Orsenigo and Marziani (1971).**

Yield and its components: green pods were harvested at proper maturity counted and weighted in each harvest, and the following data were obtained: average number of green pods/plant, average green pod weight, number of seeds/plant, yield of green pods/plant and total yield of green pods/faddan.

Seed chemical constituent: A random sample of the dried green seeds was finely ground and wet digested and total nitrogen was determined according to **Yimer *et al.*, (2007)**. Phosphorus was estimated colorimetrically according to **Olsen and Sommers (1982)**. Potassium was also determined flame photometrically due to the method described by **Jackson (1970).**

RESULTS AND DISCUSSION

Protein Characterization

When hen egg white albumin analyzed by SDS-PAGE (Fig. 1), egg white proteins presented a wide range of relative molecular masses, present in very different concentrations. The main egg white proteins, ovalbumin (54%), ovotransferrin (12%), ovomucoid (11%) and lysozyme 3.4%) these results are in harmony with **(Mine, 1995)**.

The amino acids composition of hen egg white were listed in Table 1. The contents of the hydrophobic amino acids residues (Pro, Gly, Ala, Val, Ile, Leu, Phe) are 34.54% of the total amino acids. The contents of the acidic amino acid residues (asp + glu, are 22.25 and the case lower than that of the basic amino acids (arg + lys + his; 25.82%.

Hen egg white protein was esterified with methanol in the presence of hydrochloric acid at 50 mol acid/ mole carboxylic groups, for 10 hr., at 4°C to attain esterification extents of 93%. The extent of protein degradation (native and methylated) by papain was estimated by assessing the degree of hydrolysis (DH). The hydrolysate obtained after 4 hr., degradation had the highest DH (33% and 30%) for NEA and MEA, respectively).

Vegetative Growth

As for stem length, results in Table 2 show that spraying pea plants with NEA or with MEG at 1, 1.5 and 2 ml/l or with HNEA at 1, 1.5 and 2 ml/l and with HMEA at 1 ml/l gave the highest stem length compared to the other treatments. Concerning number of branches/plant and total fresh weight/plant, spraying with NEA at 2 ml/l increased number of branches/plant and total fresh weight in both seasons with no significant differences with MEA at 2 ml/l with respect to number of branches/plant. As for number of leaves/plant, spraying pea plants with HNEA at 1.5 or 2 ml/l increased number of leaves/plant in both seasons. From the foregoing results it could be concluded that, NEA at 2ml/l increased stem length, number of branches/plant and total fresh weight /plant, whereas HNEA at 1.5 or 2 ml/l increased number of leaves/plant. Also, spraying pea plants with modified egg white protein at afferent concentration increased vegetative growth compared to control (spraying with tap water). Two PHFs increased root and leaf growth and induced morphological changes in root architecture. Besides, the treatments increased NR and GS activities, indicating a positive function of the two hydrolyzates in the inducement of nitrate conversion into organic nitrogen **(Ertani *et al.*, 2009).** The shoot, root dry weight, root area, and root length were significantly higher by 21, 35, 26, and 24%, respectively, in tomato processed plants with the protein hydrolysate at 6 m l/l than unprocessed plants. Rising the concentration of the protein hydrolysate from 0 to 10 m l/l

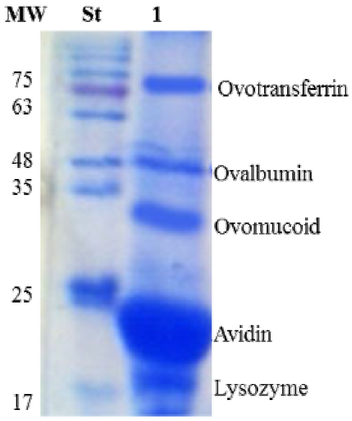

Fig. 1. SDS-PAGE of hen egg white protein (Lane 1) compared to standard molecular weight (St)

Table 1. Amino acid composition of hen egg white.

Amino acid	Concentration (%)
Aspartic	9.39
Threonine	2.97
Serine	5.44
Glutamic	12.86
Proline	0.11
Glycine	7.56
Alanine	7.30
Valine	3.58
Methionine	4.14
Isoleucine	1.64
Leucine	6.10
Tyrosine	4.87
Phenylalanine	8.25
Histidine	4.12
Lysine	21.58
Arginine	0.12

Table 2. Effect of foliar spray of pea plants with modified egg white proteins on vegetative growth of pea during 2015/2016 and 2016/ 2017 seasons

Treatment		Stem length (cm)		Number of branches/plant		Number of leaves/plant		Total fresh weight/plant (g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		54.33 de	55.33 e	1.33 fg	1.08 d	13.00 e	13.00 j	31.16 f	28.33 g
NEA	**1.0 ml/l**	56.00 c-e	56.66 de	2.00 c-e	1.83bc	18.00 bc	20.33 a-c	72.66 bc	72.66 b
	1.5 ml/l	60.33a-c	62.33 a-c	1.75 ef	1.83 bc	17.66 b-d	18.00 c-f	36.33 ef	38.16 e
	2.0 ml/l	62.00 ab	63.66 ab	3.08 a	2.58 a	14.33 e	14.00 ij	80.00 a	85.66 a
HNEA	**1.0 ml/l**	65.33 a	63.33 ab	2.50 bc	2.00 a-c	23.00 a	22.66 a	73.33 b	73.66 b
	1.5 ml/l	61.00 a-c	61.66 a-d	1.25 fg	1.16 d	22.33 a	21.66 ab	31.33 f	29.33 g
	2.0 ml/l	62.33 ab	64.66 a	1.91 de	1.83 bc	14.33 e	15.33 g-j	71.33 bc	73.00 b
MEA	**1.0 ml/l**	57.00 b-d	57.33 c-e	2.00 c-e	1.91 bc	18.00 bc	17.00 e-h	58.50 d	57.33 d
	1.5 ml/l	60.66 a-c	60.33a-e	2.08 c-e	1.58 cd	18.33 b	18.66 c-e	38.00 e	35.66 ef
	2.0 ml/l	64.00 a	63.00 ab	3.00 ab	2.41 ab	18.33 b	17.33 d-g	67.66 c	65.66 c
HMEA	**1.0 ml/l**	61.00 a-c	62.66 a-c	1.75 ef	1.91 bc	18.00 bc	19.66 b-d	57.66 d	62.33 cd
	1.5 ml/l	57.33 b-d	57.33 c-e	1.91 de	1.91 bc	19.00 b	19.66 b-d	31.16 f	31.33 fg
	2.0 ml/l	58.00 b-d	58.66 b-e	2.33 cd	2.41 ab	15.33 c-e	15.66 f-i	74.00 b	74.66 b
MAA	**1.0 ml/l**	50.66 e	49.66 f	1.16 g	1.91 bc	17.66 b-d	17.00 e-h	40.33 e	38.33 e
	1.5 ml/l	58.00 b-d	57.33 c-e	2.08 c-e	1.91 bc	15.00 de	14.66 h-j	31.66 f	31.66 fg
	2.0 ml/l	58.00 b-d	57.33 c-e	1.33 fg	1.41 cd	9.00 f	8.00 k	38.66 e	37.33 e
LSD at 0.05 level		5.82	5.45	0.54	0.64	2.68	2.38	5.55	5.14

Control = tap water (NEAative control), NEA= Native egg Albumin, HNEA= Hydrolyzed Native egg Albumin MEA=Methylated egg Albumin, HMEA= Hydrolyzed methylated egg Albumin, MAA= Multi Amino acids 24% (positive control)

increased value the total dry biomass, SPAD index, and leaf nitrogen content by 20.5, 15, and 21.5%, respectively. So, the use of plant-derived protein hydrolysate contain amino acids and short peptides excited a plant hormone-like activity, augmented nitrogen uptake and consequently crop performances **(Colla *et al.,* 2014)**.

Leaf Pigments

Results in Table 3 show that all treatments increased the concentration of chlorophyll a. b and (a+b) and carotenoids in leaf tissues compared to control (tap water). Foliar spray with HMEA at 2 ml/l increased the concentration of chlorophyll a, b, and (a+b) and carotenoids compared to other treatments with no significant different with NEA, HNEA and MAA at 2 ml/l of each with respect to chlorophyll b in both seasons. Increasing the concentration of the protein hydrolysate from 0 to 10 ml/l increased the total dry biomass, SPAD index, and leaf nitrogen content by 20.5, 15, and 21.5%, respectively. So, the use of plant-derived protein hydrolysate contain amino acids and short peptides excited a plant hormone-like activity, augmented nitrogen uptake and consequently crop performances **(Colla *et al.,* 2014).**

Table 3. Effect of foliar spray of pea plants with modified egg white proteins on chlorophyll a,b and total chlorophyll (a+b) and carotenoids during 2015/2016 and 2016/2017 seasons

		Chlorophyll a		Chlorophyll b		Total Chlorophyll (a+b)		Carotenoids	
		S1	S2	S1	S2	S1	S2	S1	S2
Control		1.254 fg	1.276 gh	0.455 g	0.480 i	1.709 h	1.756 i	0.318 j	0.336 g
NEA	**1.0 ml/l**	1.282 fg	1.280 gh	0.520 ef	0.507 hi	1.802 fg	1.788 hi	0.369 g	0.337 g
	1.5 ml/l	1.375 d	1.334 d-f	0.636cd	0.609 de	2.011 d	1.943 ef	0.381 fg	0.369 f
	2.0 ml/l	1.577 bc	1.614 b	0.752 a	0.745 a	2.330 bc	2.359 bc	0.529 c	0.526 c
HNEA	**1.0 ml/l**	1.260 fg	1.260 h	0.541 ef	0.520 gh	1.802 fg	1.781hi	0.343 hi	0.339 g
	1.5 ml/l	1.356 d	1.371 d	0.640 b-d	0.657bc	1.997 d	2.029 d	0.393 ef	0.391de
	2.0 ml/l	1.581 bc	1.617 b	0.756 a	0.760 a	2.337 bc	2.377 b	0.556 b	0.541bc
MEA	**1.0 ml/l**	1.289 e-g	1.293 f-h	0.546 e	0.550 fg	1.836 f	1.843gh	0.364 gh	0.345 g
	1.5 ml/l	1.351 d	1.377 d	0.654 bc	0.662 bc	2.005 d	2.039 d	0.413de	0.398 d
	2.0 ml/l	1.616 b	1.655 b	0.760 a	0.775 a	2.377 b	2.430 b	0.571 b	0.553 b
HMEA	**1.0 ml/l**	1.298 ef	1.320 e-g	0.610 d	0.573 ef	1.908 e	1.894 fg	0.373 fg	0.378 ef
	1.5 ml/l	1.333de	1.330 d-f	0.671 b	0.676 b	2.005 d	2.006 de	0.422d	0.391 de
	2.0 ml/l	1.735 a	1.759 a	0.757 a	0.765 a	2.493 a	2.524 a	0.601 a	0.637 a
MAA	**1.0 ml/l**	1.252 g	1.264 h	0.511 f	0.530 gh	1.763 gh	1.795 hi	0.335 ij	0.334 g
	1.5 ml/l	1.355 d	1.350 de	0.634 cd	0.625 cd	1.989 d	1.975de	0.365 g	0.381 d-f
	2.0 ml/l	1.560 c	1.542 c	0.753 a	0.748 a	2.313 c	2.290 c	0.571 b	0.537 bc
LSD at 0.05 level		0.044	0.047	0.033	0.037	0.054	0.071	0.021	0.020

Control = tap water (NEAative control), NEA= Native egg Albumin, HNEA= Hydrolyzed Native egg Albumin MEA=Methylated egg Albumin, HMEA= Hydrolyzed methylated egg Albumin, MAA= Multi Amino acids 24% (positive control)

Yield and its Components

The obtained results in Table 4 show that spraying pea plants with modified egg weight protein at different concentrations increased yield and its components compared to control (spraying with tap water) Spraying with NEA at 1.5 ml/l or with HNEA at 1 ml/l significantly increased number of green pods/plant, average green pod, yield of green pods/plant and total yield of green pods/fad. in both seasons with no significant differences with NEA at 1 ml/l and MEA at 2 ml/l with respect to number of green pods/plant, MAA at 1.5 ml/l and HNEA at 2 ml/l with respect to average green pod weight, and with NEA at 1 ml/l, HNEA at 2 ml/l and MEA at 2 ml/l with respect to yield of green pods/plant. As for number of seeds/pod, NEA at 1.5 ml/l and HMEA at 1.5 and 2 ml/l and MAA at 1.5 ml/l increased number of seeds/pod in both seasons. The simulative effect of NEA at 1.5 ml/l and HNEA at 1 ml/l on total yield of green pods/fad. may be due to that NEA and HNEA at 1.5 ml/l of each increased number of green pods/plant, average green pod weight and yield of green pods/plant. Similarly, **Calvo *et al.* (2014)** proposed that the using (through foliage or roots) of a pH trade product (Amino 16) could increase greenhouse tomato yield components under varying fertilization dosages. It is rather evident that the using of amino acids.

Table 4. Effect of foliar spray of pea plants with modified egg white proteins on peas yield and its components during 2015/2016 and 2016/2017 seasons

Treatment	Number of green pods/ plant		Average green pod weight (g)		Number of seeds/ pod		Yield of green pods / plant (g)		Total yield of green pods/fad. (ton)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	8.33 h	8.66 g	6.13 a-c	6.20 a-e	7.53 b-f	7.60 a-e	51.10 g	53.87 g	1.500 l	1.577 l
NEA 1.0 ml/l	19.66 ab	22.33a	5.80 b-d	5.83 c-g	7.43 c-f	7.50 b-e	114.13a-c	130.07 ab	3.327 de	3.469 d
1.5 ml/l	20.00 a	20.33 a-c	6.50 a	6.50 a-c	7.96 a-c	8.03 ab	131.00 a	133.03 a	3.841 a	3.905 ab
2.0 ml/l	18.00 a-d	20.33a-c	6.00 a-c	5.96 b-f	7.43 c-f	7.30 c-e	108.40a-c	121.63 a-c	3.185 ef	3.567 cd
HNEA 1.0 ml/l	18.66 a-c	19.00a-d	6.06 a-c	6.60 ab	7.60 a-e	7.53 b-e	113.33a-c	125.33 a-c	3.789 ab	4.096 a
1.5 ml/l	16.66 c-f	17.00 c-e	6.16 a-c	6.13 a-f	7.36 d-f	7.40 c-e	102.23b-d	105.23 b-e	3.008 fg	2.773 hi
2.0 ml/l	18.66 a-c	19.00a-d	6.46 ab	6.70 a	7.20 ef	7.16 d-f	121.20 ab	127.67 ab	3.586 bc	3.763 bc
MEA 1.0 ml/l	14.66 e-g	16.00 d-f	5.16 d	5.16 g	7.03 fg	7.06 ef	75.67 ef	83.00 ef	2.254 j	2.435 jk
1.5 ml/l	14.66 e-g	15.66 d-f	5.66 cd	5.76 d-g	7.80 a-d	7.86 a-c	83.10 d-f	91.17 d-f	2.454 ij	2.685 h-j
2.0 ml/l	20.00 a	20.66 ab	5.86 a-c	5.60 e-g	7.56 b-f	7.66 a-e	117.20ab	116.00 a-d	3.439 cd	3.410 de
HMEA 1.0 ml/l	16.00 c-f	16.33 d-f	6.10 a-c	6.03 a-f	7.80 a-d	8.03 ab	97.60b-e	98.73 c-f	2.375 j	2.807 hi
1.5 ml/l	17.00 b-e	16.66 d-f	5.76 cd	5.90 c-f	8.00 ab	8.10 ab	97.73b-e	98.20 c-f	2.920 gh	2.9277 gh
2.0 ml/l	20.33 a	18.66b-e	5.73 cd	5.76d-g	7.63 a-e	7.73 a-d	117.17ab	107.07 a-e	3.449 cd	3.145 fg
MAA 1.0 ml/l	15.66 d-g	15.33 ef	5.83 a-d	5.66 e-g	7.46 b-f	7.30 c-e	91.40 c-f	86.60ef	2.670 hi	2.587 ij
1.5 ml/l	14.00 fg	17.00 c-e	6.46 ab	6.36 a-d	8.13 a	8.20 a	90.63 c-f	108.07 a-e	2.665 i	3.195 ef
2.0 ml/l	13.00 g	13.33 f	5.56 cd	5.50 fg	6.53 g	6.56 f	72.53 fg	73.47 fg	1.842 k	2.185 k
LSD at 0.05 level	2.82	3.46	0.69	0.69	0.54	0.61	24.15	27.53	0.253	0.253

Control = tap water (NEAative control), NEA= Native egg Albumin, HNEA= Hydrolyzed Native egg Albumin MEA=Methylated egg Albumin, HMEA= Hydrolyzed methylated egg Albumin, MAA= Multi Amino acids 24% (positive control)

Seed Chemical Constituents

Results in Table 5 illustrate that spraying with modified egg white protein at different concentration increased N, P, K and total protein in seeds compared to control (spraying with tap water). Spraying with NEA at 1.5 ml/l increased N, P, K and total protein in seeds in the 1st season, whereas spraying with MAA at 2 ml/l increased N and total protein in seeds, MAA at 1 ml/l increased P content and HMEA at 2 ml/l increased K content in both seasons.

Several studies indicated that soil microorganisms used 30–40% of amino acid-C for respiration and the remaining amino acid-Cfor cell biomass production and maintenance **(McMahon, 2008)**. Moreover, 30–40% of the N linked with the respired amino acid-C was consistently excreted into the soil as ammonium-N, which can be taken up by plants and microbes or further oxidised to produce nitrate.

Table 5. Effect of foliar spray of pea plants with modified egg white proteins on seed chemical content during 2015/2016 and 2016/2017 seasons

Treatment		N (%)		P (%)		K (%)		Total protein (%)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		2.48 cd	2.35 h	0.513 c-e	0.543 ab	1.94 g	1.71 i	15.50cd	14.71 h
NEA	**1.0 ml/l**	2.96 b	2.62 f	0.500 e	0.490 cd	1.98 f	1.88 h	18.52 b	16.39 f
	1.5 ml/l	3.33 a	2.95 e	0.556 a	0.510 b-d	2.40 a	2.10 cd	20.81 a	18.46 e
	2.0 ml/l	2.54 c	3.25a-c	0.436 f	0.503 b-d	1.84 i	2.44 a	15.87 c	20.31 a-c
HNEA	**1.0 ml/l**	3.07 ab	2.94 e	0.546ab	0.530 a-c	2.30 b	2.10 d	19.19 ab	18.37 e
	1.5 ml/l	2.23 d	3.42 a	0.556a	0.506 b-d	1.92 gh	2.16 c	13.93 d	21.39 a
	2.0 ml/l	2.53 c	3.25 a-c	0.510 de	0.483 d	1.75 j	1.83 h	15.81 c	20.33 a-c
MEA	**1.0 ml/l**	3.30 a	3.09 c-e	0.513c-e	0.510 b-d	1.74 j	2.11 cd	20.62 a	19.35 c-e
	1.5 ml/l	2.45 cd	2.39 gh	0.513c-e	0.530 a-c	1.89 h	1.84 h	15.33cd	14.98gh
	2.0 ml/l	2.54 c	2.99 e	0.496 e	0.536 ab	1.91 gh	2.09 de	15.91 c	18.69 e
HMEA	**1.0 ml/l**	2.65 c	2.54 fg	0.513c-e	0.503 b-d	1.99 f	1.84 h	16.56 c	15.89 fg
	1.5 ml/l	2.96 b	3.04 de	0.516 b-e	0.556 a	2.10 e	1.96 g	18.52 b	19.02 de
	2.0 ml/l	3.22 ab	3.21 b-d	0.536a-d	0.433 e	2.44 a	2.44 a	20.14 ab	20.06 b-d
MAA	**1.0 ml/l**	3.22 ab	2.56 fg	0.533a-d	0.553 a	2.17 d	2.03 ef	20.14 ab	16.04 fg
	1.5 ml/l	2.97 b	3.29 ab	0.543a-c	0.560 a	2.26 c	1.96 fg	18.56 b	20.60 ab
	2.0 ml/l	3.23 a	3.25a-c	0.550 a	0.506 b-d	1.84 i	2.29 b	20.23 a	20.35a-c
LSD at 0.05 level		0.26	0.18	0.031	0.40	0.03	0.06	1.66	1.17

Control = tap water (NEAative control), NEA= Native egg Albumin, HNEA= Hydrolyzed Native egg Albumin MEA=Methylated egg Albumin, HMEA= Hydrolyzed Methylated egg Albumin, MAA= Multi Amino acids 24% (positive control)

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الملخص العربي

الرش الورقى لنباتات البسلة ببروتين بياض البيض المعدل لحث النمو والإنتاجية

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هذا العمل تم إجراؤه أثناء موسمين شتويين متتاليين ٢٠١٥/ ٢٠١٦م و٢٠١٦/٢٠١٧ تحت ظروف الأراضي الرملية مع نظام الري بالتنقيط بمزرعة الخطارة التجريبية، كلية الزراعة جامعة الزقازيق، محافظة الشرقية، مصر لدراسة تأثير تركيزات مختلفة من بروتين بياض البيض الأصلي والمعدل والأحماض الأمينية الكلية كمعاملات رش ورقى على النمو، مضادات الأكسدة، المحصول والتركيب الكيماوى لبذور البسلة صنف ماستربى، الرش الورقى لنباتات البسلة ببروتين بياض البيض الأصلى (NEA) بمعدل ٢ مللى/لتر أدى لزيادة طول الساق وعدد الأوراق/ نبات والوزن الكلى الطازج للنباتات فى كلاً الموسمين، الرش الورقى ببروتين بياض البيض المعدل الميثيلى المائى (HMEA) بمعدل ٢ مللى/لتر أدى لزيادة تركيز الكلورفيل أ ، ب و(أ+ب) والكاروتينويدات مقارنة بباقى المعاملات، المعاملة بالأحماض الأمينية الكاملة ٢٤% (MAA) بمعدل ٢ مللى/لتر أدت لزيادة النيتروجين والبروتين الكلى، المعاملة MAA بمعدل ١ مللى/لتر أدت لزيادة النسبة المئوية للفوسفور (P%) أما HMEA بمعدل ٢ مللى/لتر أدت لزيادة النسبة المئوية للبوتاسيوم (K%) فى البذور فى كلاً الموسمين، NEA بمعدل ١,٥ مللى/لتر أو HNEA بمعدل ١ مللى/لتر أدت لزيادة عدد القرون الخضراء/نبات، متوسط وزن القرن الأخضر ومحصول القرون/نبات المحصول الكلى للقرون الخضراء بينما HMEA بمعدل ١,٥ مللى/لتر أو MAA بمعدل ١,٥ مللى/لتر أدت لزيادة عدد البذور/موسم.

الكلمات الإسترشادية: البازلاء، بروتين بياض البيض، التحليل الميثيلي، تحليل البروتين المائي، المحصول.

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