Minufiya J. Agric. Res. Vol.36 No. 2: 337-357 (2011) "http://www.mujar.net"

التأثيرات المتبادلة بين الزراعة الحيوية والعضوية وتكنولوجيا التصنيع على محصول ومنتجات البطاطس

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الملخص العربي :

أجريت هذه التجربة فى مزرعة تجارب الراهب الخاصة بكلية الزراعة بشبين الكوم جامعة المنوفية أثناء موسمى الزراعة ٢٠٠٦ – ٢٠٠٧ لدراسة تأثير التسميد المعدنى والحيوى والعضوى على المحصول الكلى والمحصول الصالح للتسويق والمكونات الكيميائية لدرنات البطاطس ودراسة تأثير التصنيع على محتوى النترات فى منتجات البطاطس ، صممت التجربة فى قطاعات تامة العشوائية فى ثلاث مكررات وتم استخدام نوعين من التسميد المعدنى هما نترات الأمونيوم ، ونترات الأمونيوم + سلفات الأمونيوم (١:١) بمعدل ١٥٠ كجم آزوت للفدان بالإضافة إلى أربع أسمدة حيوية وهى الريزوباكترين والنيتروبين والبيوجين والميكروبين بمعدل ٢ كجم للفدان وأيضاً تم استخدام السماد العضوى FYM بنفس معدل التسميد المعدنى ، وقد أوضحت النتائج ما يلى :

- أنه تُوجد اختلافات معنوية بين معاملات التسميد المختلفة بالنسبة لصفة المحصول حيث أعطت معاملة نترات الأمونيوم أعلى محصول للبطاطس فى موسمى النمو بينما أعطت معاملة التسميد العضوى FYM أعلى محصول صالح للتسويق .
- بالنسبة لمحتوى الدرنات من النشا والمادة الجافة فقد زادت بالتسميد العضوى والحيوى بينما انخفضت نسبتها بالتسميد المعدنى وكانت أعلى قيمة للمادة الجافة بالتسميد الحيوى النيتروبين الذى أعطى أعلى قيمة لحامض الأسكوربيك أيضاً أما محتوى الرماد فقد زاد معنوياً باستخدام معاملتى التسميد المعدنى بينما انخفض محتوى الألياف وكان هذا الإنخفاض أعلى ما يُمكن باستخدام الريزوباكترين .

- بالنسبة لمستوى النترات نجد أنه زاد باستخدام التسميد المعدنى حيث أعطت معاملة نترات الأمونيوم أعلى قيمة (٣٤٠.٢٦ ملجم / كجم) وكان أقل مستوى للنترات باستخدام التسميد العضوى FYM (١٩٩.٥٤ ملجم / كجم) .
- بالنسبة للمكونات الكيميائية للبطاطس بعد التحمير نجد أن محتوى الدهن ارتفع إلى ٢٦.٢% فى شرائح البطاطس المسمدة بنترات الأمونيوم مقابل ١٢.٣% لشرائح البطاطس المسمدة بالنيتروبين ، كما نجد أن مستوى النترات بعد التصنيع تراوحت بين ١٤.٤% لأصابع البطاطس المحمرة لمعاملة الكنترول كحدٍ أقصى إلى ٣.٨% فى أصابع البطاطس المحمرة لمعاملة الميكروبين وفى شرائح الشيبسى تراوحت بين ١٢.٩% إلى ١.٧% لمعاملة الريزوباكترين ، أما فى البطاطس المطبوخة فقد تراوحت بين ١١.١% للكنترول إلى ١.٩% لمعاملة الريزوباكترين .

INTERACTIVE EFFECTS BETWEEN BIO-, ORGANIC-AGRICULTURE AND PROCESSING TECHNOLOGY ON YIELD AND PRODUCTS OF POTATO

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(Received: Feb. 14, 2011)

ABSTRACT:*This study was carried out at El-Raheb Experiment Farm, Faculty of Agriculture, Minufiya University, Shibin El-Kom, during the two successive seasons of 2006 and 2007 to study the effect of mineral-, bio and organic fertilization on marketable and total yields, chemical constituents of potato tubers as well as the effect of processing on nitrate content of potato products. In the two experiments, a randomized complete block design with three replicates was used. Mineral N-fertilization in 2 sources; i.e., ammonium nitrate and or ammonium nitrate + ammonium sulphate (1 : 1 w/w) at 150 kg N/fed. was applied. In addition, four biofertilizers namely Rhizobacterin, Nitrobein, Biogene and Microbein at a rate of 2 kg / fed. as well as Farmyard Manure (FYM) were studied. The results showed that, highly significant varietal differences were found among fertilizer treatments, where ammonium nitrate treatment gave the highest yield of potato in two growing seasons. High marketable yield of potato had got by organic fertilizer FYM. Starch and dry matter contents increased by FYM and biofertilizer whereas decreased by mineral fertilizers. Ash content was increased significantly by both used mineral fertilizers, while the fibers content was decreased significantly and this reduction was very high by application of Rhizobacterin. The highest nitrate level was recorded by ammonium nitrate fertilization (340.26 mg/kg) and the lowest value was achieved by FYM (199.54 mg/kg). Concerning chemical constituents of potato after frying, fat content become 26.24% in potato slices fertilized by ammonium nitrate, against 12.34% only for slices fertilized by Nitrobein. Nitrate level decreased from 14.4 to 3.8% in French fries and from 12.9 to 1.7% in chips and from 11.1 to 1.9% in cooked potato by soaking it in 0.5% sodium metabisulfite solution.*

Key words: *Potato, biofertilizers, FYM, total yield, marketable yield, chemical constituents, nitrate content, French fries, chips, cooked potatoes.*

INTRODUCTION

In recent years, man-all-over the world began to come back to nature in various fields of life (bio-organic farming system) because of excessive application of nitrogenous chemical fertilizers, to enhance growth rates and yield of crops, which is considered a common agricultural practice in developing countries (Gomaa, 1995). This extreme fertilizer application often leads to the accumulation of high levels of nitrates in plant tissues (Greenwood and Hunt, 1986) and ground water (Viets and Hageman, 1971). High levels of nitrate in the diet can indirectly inhibit oxygen transport by blood, a medical condition known as methemoglobinemia, in infants because of the reduction of nitrate to nitrite (Lyons *et al.,* 1994). Nitrites can react with amines and may be converted to nitrosamines which usually cause cancer (Whitney *et al.,* 1990).

Potato (*Solanum tuberosum* L.) cv. *Diamant* is considered to be the main vegetable crop in Egypt which are used for both exportation and local consumption as it has a good flavour and a high nutritional value. It contains high starch and protein of relatively higher biological value (McCay *et al.,* 1987). Also, increasing dry matter content in the tubers led to low moisture content of them, an increase in processed yield with low fat content and high crispness for the final product especially Diamant variety (Harris, 1992 and Youssef, 2004).

Therefore, this work aimed to study the effects of mineral-, bio- and organic fertilizers on yield and its components, chemical composition and minimizing the accumulation of nitrate in potato and its products.

MATERIALS AND METHODS

Two field experiments were carried out at El-Raheb Experimental Station of the Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt during two successive seasons 2005 - 2006 and 2006 - 2007 on Potato *Solanum tuberosum*, cv. Diamant to study the effects of some nitrogenous mineral fertilizers (Ammonium nitrate, Amonium nitrate + Amonium sulfate 1 : 1 w/w), some biofertilizers (Rhizobacterine, Nitrobine, Biogene and Microbin) and organic manure as farm yard manure (FYM) on yield and its components, chemical composition and the influence of frying of chips and French fries on the content of nitrate in potato products.

A- Agricultural treatments:

Potato tuber seeds variety Diamant was cultivated in 13th and 14th February of 2006 and 2007 seasons, respectively. Diamant cv. was used in this study because its important cv. for both fresh market and processing. Tuber seeds of potato used in this experiment were kindly given to us by Producers and Exporters Union of Horticultural Crops in Shibin El-Kom. Tuber seeds were cutting into a suitable size of about 50 grams at least which contain two to four eyes. The prepared potatoes were left for some days at room temperature to encourage the suberization process, which protect the cuts from drying and mold growth. Tuber seeds were planted at 30 cm apart on rows 5 meter in length and 70 cm in width. Each plot consisted of 4 rows. The plot area was 14 m^2. A completed randomized block design was used with 3 replications. Moreover, the experimental units were separated from each other by not less than 150 cm alley. Cultural practices such as cultivation, irrigation, pest and diseases control were applied when needed. The harvest was carried out at 115 days after the sowing date.

Nitrogen was applied at 150 kg N / feddan as ammonium nitrate (33.5% N) alone or ammonium nitrate + ammonium sulphate (20.5% N) (1 : 1 w/w) which was applied in two doses, the first dose was applied at 40 days after the sowing date and the second was applied at 60 days from planting. Phosphorus was added at 90 kg P_2O_5 / feddan during the soil preparation as calcium superphosphate (15.5% P_2O_5).

Efficient local strains of Rhizobacterin, Nitrobein, Biogene and Microbein were obtained kindly from Pharmaceutical Department, National Research Center, Giza, Egypt. The prepared culture from each bacterial type contained 10^7 cell/ml. Potato tuber seeds were inoculation with the different bacterial culture at a rate of 2 kg / fed. for 1 hr before sowing. FYM was applied before planting during soil preparation at the rate of 150 kg N/fed.

B- Technological treatments (Processing):

At harvest period, tuber samples were weighed, Carborandom peeled and dipped under water surface in suitable container to avoid enzymatic darkening. Then the potato tubers were sliced by an electrical slicer (Mark Essedue, Model TG 220, Italy) into 1.35 – 1.45 mm thickness or to shape and treated as follows:

Treatments of potato slices:

To prevent the browning in potato tubers the slices were soaked in the following solutions for 4 min.

1. Distilled water (control).
2. 0.5% citric acid (CA).
3. 0.5% ascorbic acid (AA).
4. 0.5% CA + 0.5% AA.
5. 2.0% NaCl.
6. 0.5% $CaCl_2$.
7. 0.5% $CaCl_2$ + 0.5% CA.
8. 0.5% sodium metabisulfite (El-Nasr Pharma, Ceutical Chemicals).

The prior solutions used as browning inhibitors as mentioned by Molnar and Friedman (1990) as well as Almaghrabi (2000). Excess of moisture in treated slices was drained out and then cooked or fried.

Frying test:

1- Chips:

A sample of 400 gm of potato slices (1.35 – 1.45 mm thickness) exposed to frying in an electrical fryer with a capacity of 20 litres of oil (Mark Sillko, Model FF20G, Italy) using cotton seed oil at 180°C for 5 min. Then cooled, dried and grinded to determine nitrate content.

2- French fries:

300 gm of strips exposed to frying in an electrical fryer at 180°C for 6 min for final French fries followed by drying and grinding to determine nitrate content.

In both seasons, potatoes were harvested at 115 days after planting and total yield (ton / fed.) as well as marketable yield (ton / fed.) for potato tubers were calculated.

Ash, protein, starch, fat and crude fibres were determined according to the methods described by A.O.A.C (1990). Reducing sugars and non reducing sugars which determined by the method of Dubois *et al.* (1956). Determination of nitrate content was carried out after the harvesting to know the effects of mineral, biofertilizer and FYM on nitrate content. Also, the nitrates content was determined after the frying processes. Nitrates were determined according to Pearson *et al.* (1981).

RESULTS AND DISCUSSION

A. Agricultural treatments:

1. Effect of mineral-, bio- and organic fertilizers:

1.1. Total tuber yield:

As shown in Table (1), the different treatments of fertilization augmented significantly total tubers yield of potato expressed as ton/fed.

Using mineral fertilizers such as ammonium nitrate at rate of 150 kg N / feddan (a recommended dose) or ammonium nitrate + ammonium sulphate (1 : 1 w/w) at the same rate gave the first and second highest of total yield. The increment percentages in total yield were about 124.28 and 96.94% as well as 100.35 and 77.35% in the first and the second seasons, respectively, compared with the control. So, these findings are in partially closed with those obtained by Pacha (2003) on potato. The favourable effects of N sources on yield occurs herein may be due to not only to its physiological effects on potato plant growth, but also to the alteration in the hormonal balance owing to N fertilization such as the rise in GA (Gibbrilin) and auxin concentration (Krauss, 1981), which positively affected both of the tuber formation and the average tuber weight.

Concerning the effect of biofertilizer treatments on potato tuber yield, data in

Table (1) indicated that, all biofertilzier treatments resulted in significant increase in total yield of potato tubers, except Biogene treatment, where the increase was no significant comparing with the control. The application of Nitrobein followed by Microbein gave the greatest values of total tuber yield of potatoes without significant differences between both treatments. These results were true in both growing seasons. The increases occurred in total yield due to using biofertilizers may be imputed to the increase in plant growth characteristics, which increased pohotosynthesis and hence tuber yield. Also, non-symbiotic bacteria presented in all biofertilizers, namely Nitrobein, Microbein and Rhizobacterin have beneficial effects on plant host by confirming plant root growth and functions, improving water status and N assimilation in plant cells (Choudhary *et al.,* 1984), which consequently enhances tuber yield.

The obtained results are in correspondence with those of El-Mandoh and Abdel-Magid, 1996 as well as El-Ghinbihi and Ali (2001). Also, Ashour *et al.* (1997), who found that, inoculating potato seed tubers with biofertilizer led to a significant increase in total tuber yield than the control.

Regarding the effect of FYM, the results in Table (1) indicated that, FYM had a favourable effect on total yield of potato tubers. The increment percentages reached 59.6 and 50.8% in the 2006 and 2007 growing seasons, respectively.

Increases in yield resulted from FYM fertilizer treatment were attributed primarily to absorb more available N supplied in FYM compared with inorganic sources of NO_3-N, that are susceptible to N loss mechanisms such as the leaching during the growing period. Therefore, the efficiency with which available fertilizer N is utilized may be marginally improved when FYM fertilizer is supplied to vegetables crops (Smith and Hadley, 1989 as well as Gawish, 1997). The improving effect of FYM on tubers total yield were reported also by Anwar (2005) on potato and Allian (2005) on artichoke who found that FYM encourages the relase of macro- and micro-elements as well as some amino acids which are important for better plant growth and higher tuber yield.

1.2. Marketable tuber yield:

Data in Table (1) showed clearly that, the highest percent of marketable yield was obtained by FYM treatment followed by Nitrobein treatment for the growing seasons of 2006 and 2007, respectively.

On the other hand, the lowest percent of marketable tubers yield was recorded by the control followed by ammonium nitrate + ammonium sulphate treatment in 2006 growing season, while the lowest one was by the control which followed by ammonium nitrate alone in 2007 growing season. It is

worthy to mention that, the treatments which gave the higher marketable yield gave the lowest non marketable yield. These results agree with those obtained by Kamla-Singh (2000) and Indriesh *et al.* (2003) on potato. The increment in yield and its components, in most cases might be also related to the action of micro-elements (Zn, Cu and Mn) which presented in the FYM and biofertilizers. Micro-elements are known to raise the efficiency of photosynthesis and carbohydrate accumulation, which leading to more vigorous growth and improving performance of yield and its components.

2. Chemical constituents:

2.1. Total-, reducing- and non-reducing sugars:

Data of total, reducing and non-reducing sugars responses to mineral, bio- and organic fertilization are presented in Table (2). Results showed a reduction in reducing sugars of all treatments compared with the control.

It is clearly that, the reduction was low in case of applying Biogene and FYM treatments, while other treatments, i.e., Microbein, Rhizobacterin and Nitrobein reduced reducing sugars with 0.07, 0.08 and 0.09%, respectively compared with the control (0.33%). From the previous results, we noticed that, all treatments caused a reduction in reducing sugars content (glucose and fructose) which led to reduce in Millard reaction between the reducing sugars and amino acids, which plays a major role in processing and nutritional qualities of potato tubers. Meanwhile, treating potato plants with mineral-, bio- and organic fertilizers under this study also decreased reducing sugars level.

On the other hand, non reducing sugars increased significantly by application of mineral-, bio- and organic fertilizers, except Biogen which increased it non-significantly compared with the control. These results agree with those obtained by Abdel-Fattah (1998) and disagree with those obtained by Abdulla (1999).

In relation to total sugars, Nitrobein, Rhizobacterin, Microbein and Ammonium nitrate increased it significantly, but other treatments had no significant effect on it compared with the control.

2.2. Starch content:

It is clear from the data in Table (2) that, treatments of biofertilizers such as Microbein, Rhizobacterin, Biogene and FYM treatment increased significantly starch content compared with the control.

Meanwhile, mineral fertilizers such as ammonium nitrate and ammonium nitrate + ammonium sulphate (1 : 1, w/w) decreased it significantly compared with the control. In this respect, Nitrobein had no significant effect on starch content compared with the control.

Table (1 – 2)

The results are in a disagreement with those obtained by Abou Hussein (2001), Mohamed (2001) and Farag (2007), however, these results are in a agreement with those obtained by Abdulla (1999) as well as Ghoneim and Abdel-Razik (1999), who reported that, application of manure increased significantly total tuber starch.

2.3. Total crude protein:

The results presented in Table (2) showed that, crude protein content of potato tubers was 6.13% on dry weight basis for the control treatment (without fertilizers), while this value increased significantly by application of mineral fertilizers namely ammonium nitrate and ammonium nitrate + ammonium sulphate (1 : 1 w/w), where these values of crude protein were 9.76 and 8.31%, respectively. Also, applying of biofertilizers led to significantly an increase in crude protein content compared with the control. Moreover, FYM treatment induced a high crude protein content (6.90%).

From the previous results, we noticed that, all treatments of fertilizers under this study significantly increased crude protein content (%) compared with the control. However, Zaid (1992) recorded increases in soybean seeds and barley grains proteins as a result of inoculation with nitrogen fixing biofertilizers. Also, El-Ghinbihi and Ali (2001) indicated that, treating potato seed tubers with Halex 2 (biofertilizer) increased N concentration compared with the control, where this increase may due to the fact that N is considered an important constituent of protein synthesis (Chaurasian and Singh, 1995).

2.4. Ether extract, total ash and crude fibers contents:

As shown in Table (2), data indicated that, the different fertilization treatments had no significant effect on ether extract content in potato tubers. On the other hand, total ash content increased significantly by application of mineral fertilizers such as ammonium nitrate + ammonium sulphate (1 : 1 w/w) which had the highest value of total ash content compared with the control. While the other different treatments had no significant effect on total ash content. Also, crude fibers content, affected significantly by all treatments which are used under this study, where total fibers content decreased by these treatments significantly and this decrease was very high in the case of applying Rhizobacterin and Nitrobein treatments, respectively.

3. Tubers quality:

3.1. Dry matter content:

Potato tubers seed treated with mineral-, bio- and organic fertilizers affected in its dry matter (%) significantly compared with the control. While mineral fertilizers namely ammonium nitrate and ammonium nitrate + ammonium sulphate (1 : 1 w/w), decreased its dry matter (%) compared with the control.

On the other hand, biofertilizers treatments caused the highest value of dry matter (%) in the case of Nitrobein treatment followed by Microbein, Rhizobacterin and finally Biogene treatments (25.75, 25.19, 25.10 and 24.59%, respectively) compared with the control (19.55%).

Moreover, FYM treatment increased dry matter content of potato tubers (24.35%).

In this respect, it was reported that, the high dry matter contents led to a high yield, low fat content and a high crispness level for final product (Harris, 1992). Increasing the dry matter content in tubers due to using biofertilizers and FYM treatments led to a high quality in the production of chips and French fries potato (final products).

These results agree with those obtained by Abou-Hussein *et al.* (2002 a) who showed that, the biofertilizers increased dry matter in potato tubers cv. Nicola, as well as Covarrubias Ramirez *et al.* (2005) and Farag (2007).

3.2. Vitamin C content:

Results in Table (3) revealed that, using mineral fertilizers such as ammonium nitrate and ammonium nitrate + ammonium sulphate (1 : 1 w/w) increased ascorbic acid content in potato tubers, but this increase was non-significant for the former compared with the control. Also, biofertilizer treatments increased significantly ascorbic acid content, especially Nitrobein which induced the highest value of it, followed by Biogene then Microbein and Rhizobacterin treatments, respectively. Ascorbic acid in potato tubers plays an important role in preventing tuber discoloration (Muller, 1989). Moreover, increasing in ascorbic acid content was significantly due to the application of FYM. These results are in agreement with those obtained by El-Ghinbihi and Ali (2001) on potato. The positive effect of biofertilizer on vitamin C results in a stimulative effect on the photosynthetic processes (Yamaguchi and Wu, 1978).

3.3. Nitrate content:

Data of NO_3 contents in potato tubers were influenced by mineral-, bio- and organic fertilizers as presented in Table (3), where significant differences were observed. It could be noticed that, applying mineral fertilizers, namely ammonium nitrate and ammonium nitrate + ammonium sulphate (1 : 1 w/w) increased nitrate content in tubers in comparison with the control. These percentages were 15.70 and 13.96%, respectively. However, using biofertilizers namely Nitrobein, Rhizobacterin, Microbein and Biogene at a rate of 2 kg/fed. reduced significantly nitrate content by decreasing percents of 21.05, 23.65, 19.24 and 17.72, respectively compared to the control.

Generally, applying FYM gave the lowest NO_3-value compared with the control and other treatments where the decreasing percentage in nitrate was 32.15 compared with the control. Regarding the effect of N forms, the results in Table (3) indicated that, ammonium nitrate in a mixture with ammonium sulphate (1 : 1 w/w) at a rate of 150 kg N/fed., caused less nitrate accumulation. This reduction in NO_3 may be due to the role of SO_4 ion which promotes the slow release of NH_4 through delaying its hydrolysis, conserving it in the vicinity of the root for longer time (Broadbent and Nakashima, 1968). Moreover, ammonium N is very slowly nitrified, therefore nitrate accumulation in plants is very low comparing with nitrate N (Chu *et al.,* 1984 as well as Goh and Vityakon, 1986).

On the other hand, NH_4-N and NO_3-N increased N, P, K, Ca and Mg concentrations in leaves and thus causing a high mineral content in the tissue for prolonged period which leads to a depression in the activity of nitrate reductase in plant and consequently accumulate much more nitrate (Bakr and Gawish, 1997 as well as Pacha, 2003).

These results go in a line with those reported by Awad (2002) and Farag (2007).

B. Processing of potato:

1. Effect of frying on chemical constituents of potato:

Data in Table (4) showed that, generally chemical constituents of potatoes were affected significantly by frying process, where potato slices which produced from plants fertilized with ammonium nitrate alone showed the highest crude fat content (26.24% on d.w. basis), whereas those slices which obtained from plants fertilized with Nitrobein had the lowest one (12.34%) comparing with other fertilization treatments which their contents varied from 13.14% in Microbein treatment to 24.35% in ammonium nitrate + ammonium sulphate (1 : 1 w/w).

This reduction in absorbing oil in potato slices from tubers of plants fertilized with biofertilizers and FYM after frying process may be due to the high dry matter content of such slices. This result is in agreement with that obtained by Youssef (2001) and Youssef (2004).

2. Effect of processing on nitrate level in potato products:

The high consumption rate of potato tubers is attributed to both palatability and high nutritive value. A part from chemical constituents in potato tubers influence positively its nutritive value, whereas other undesirable substances reduce it and have a toxic effect at high levels on human such as nitrate which shouldn't exceed 0.2 mg NO_3 . kg^{-1} body weight, as reported by Hill (1999).

Table (3 – 4)

The significance of nitrate to human health derives from the fact that nitrate can be converted *in vivo* to nitrite which interacts with haemoglobin to affect the oxygen transport mechanism giving rise to a condition known as methaemoglobinaemia (WHO, 1977). Ingested nitrate may be converted to nitrite (causing methaemoglobinaemia) or even carcinogenic nitrosamines (Blom-Zandstra, 1989). Wilson (1994) suggested that, the nitrate in prepared baby food may contribute to hemoglobinaemia found in infants and may produce certain toxic, if not leathal, condition in adults.

Acceptable Daily Intake (ADI) for nitrate was 0.5 mg/kg body weight for sodium nitrate equivalent to 0.307 mg nitrate ion / kg body weight [FAO/WHO Expert Committee on Food Additives JECFA (1973) and SCF (the European Communities Scientific Committee for Food in 2002].

In spite of fertilizer treatments applied led to reduction in nitrate content in potato tubers, we noticed that, the nitrates level was higher than that of ADI (acceptable daily intake), so we must be known the role of processing in decreasing or reduction nitrate level in final potato products.

From Tables (5, 6 and 7) we have seen that, cooking and preparation processes of both French fries and chips decreased nitrates level in the final product comparing with the raw material, where the largest amount of nitrate was removed during peeling, cutting and frying of potato slices which were soaked in infusion solutions such as citric acid, ascorbic acid, $CaCl_2$, NaCl, sodium meta-bisulfite and combinations of them. Therefore, some steps of French fries and chips production such as peeling, slicing and washing, as well as frying at a high temperature (180°C), allowed to remove most of nitrates in potatoes (Hill, 1999 and Peksa *et al.,* 2006).

From the comparison of processing methods, it could be noticed that, there were markedly differences between them on percentage of nitrate reduction, where cooking was the lowest one (72.49%) against (76.37 and 72.50) for French fries and chips, respectively. This result disagree with that obtained by Mozolewski and Smoczymski (2004), who demonstrated that, the greatest decrease in nitrate level was found in deep fried potatoes and significantly higher in peeled potato tubers subjected to thermal direct contact with water than in steam or oil. Such percents were 88.99, 85.60 and 87.10 for potatoes soaked in 0.5% sodium metabisulfite for 4 minutes before cooking and processing for French fries and chips, respectively.

Also, potato slices soaked in 0.5% ascorbic acid and 0.5% citric acid solution for 4 min gave the highest loss in nitrates.

These results are in agreement with those obtained by Gaballa (2000).

Table (5)

Table (6)

Table (7)

Concerning the interactions between fertilization and presoaking, nitrate reductions reached 98.14, 95.46 and 98.30% for cooked potatoes, French fries and chips, respectively, due to soaking in 0.5% sodium metabisulfite solution for 4 min for Rhizobacterin fertilized potatoes against 95.54, 94.75 and 97.85% for FYM fertilized ones as well as, 91.99, 94.35 and 95.85% for those fertilized ones with ammonium nitrate and 93.99, 95.68 and 96.81% for those fertilized with ammonium nitrate + ammonium sulphate (1 : 1 w/w), respectively. Finally, it could be clearly noticed that, the nitrate levels ranged from 14.4 to 3.83% for French fries soaked in 0.5% sodium metabisulfite for 4 min before frying.

While these percentages varied from 12.9 to 1.7 and from 11.01 to 1.86% for chips and cooked potatoes, respectively. Also, from these data we noticed that, there were non-significant differences among different processing methods on nitrate level because of pre-soaking in the same chemical solution while nitrate level differed significantly by pre-soaking in different chemical solutions before processing.

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التأثيرات المتبادلة بين الزراعة الحيوية والعضوية وتكنولوجيا التصنيع على محصول ومنتجات البطاطس

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الملخص العربي :

أجريت هذه التجربة فى مزرعة تجارب الراهب الخاصة بكلية الزراعة بشبين الكوم جامعة المنوفية أثناء موسمى الزراعة ٢٠٠٦ – ٢٠٠٧ لدراسة تأثير التسميد المعدنى والحيوى والعضوى على المحصول الكلى والمحصول الصالح للتسويق والمكونات الكيميائية لدرنات البطاطس ودراسة تأثير التصنيع على محتوى النترات فى منتجات البطاطس ، صممت التجربة فى قطاعات تامة العشوائية فى ثلاث مكررات وتم استخدام نوعين من التسميد المعدنى هما نترات الأمونيوم ، ونترات الأمونيوم + سلفات الأمونيوم (١:١) بمعدل ١٥٠ كجم آزوت للفدان بالإضافة إلى أربع أسمدة حيوية وهى الريزوباكترين والنيتروبين والبيوجين والميكروبين بمعدل ٢ كجم للفدان وأيضاً تم استخدام السماد العضوى FYM بنفس معدل التسميد المعدنى ، وقد أوضحت النتائج ما يلى :

- أنه تُوجد اختلافات معنوية بين معاملات التسميد المختلفة بالنسبة لصفة المحصول حيث أعطت معاملة نترات الأمونيوم أعلى محصول للبطاطس فى موسمى النمو بينما أعطت معاملة التسميد العضوى FYM أعلى محصول صالح للتسويق .
- بالنسبة لمحتوى الدرنات من النشا والمادة الجافة فقد زادت بالتسميد العضوى والحيوى بينما انخفضت نسبتها بالتسميد المعدنى وكانت أعلى قيمة للمادة الجافة بالتسميد الحيوى النيتروبين الذى أعطى أعلى قيمة لحامض الأسكوربيك أيضاً أما محتوى الرماد فقد زاد معنوياً باستخدام معاملتى التسميد المعدنى بينما انخفض محتوى الألياف وكان هذا الإنخفاض أعلى ما يُمكن

باستخدام الريزوباكترين .

- بالنسبة لمستوى النترات نجد أنـه زاد باستخدام التسميد المعدنى حيث أعطت معاملـة نترات الأمونيوم أعلـى قيمـة (٣٤٠.٢٦ ملجم / كجم) وكـان أقل مستوى للنترات باستخدام التسميد العضوى FYM (١٩٩.٥٤ ملجم / كجم) .
- بالنسبة للمكونات الكيميائية للبطاطس بعد التحمير نجد أن محتوى الدهن ارتفع إلـى ٢٦.٢% فـى شرائح البطـاطس المسـمدة بنتـرات الأمونيـوم مقابـل ١٢.٣% لشـرائح البطـاطس المسـمدة بالنيتروبين ، كما نجد أن مستوى النترات بعد التصنيع تراوحت بين ١٤.٤% لأصابع البطاطس المحمـرة لمعاملـة الكنتـرول كحدٍ أقصـى إلـى ٣.٨% فـى أصـابع البطـاطس المحمـرة لمعاملـة الميكروبين وفى شرائح الشيبسى تراوحت بين ١٢.٩% إلى ١.٧% لمعاملة الريزوباكترين ، أما فى البطاطس المطبوخة فقد تراوحت بين ١١.١% للكنترول إلى ١.٩% لمعاملة الريزوباكترين .

Table (1): Effect of mineral-, bio- and organic fertilizers on total and marketable yields of potato tubers during 2006 and 2007 growing seasons.

Treatments	2006				2007			
	Total yield (ton/fed)	Increment percent (%)	Marketable yield (ton/fed)	Marketable yield (%)	Total yield (ton/fed)	Increment percent (%)	Marketable yield (ton/fed)	Marketable yield (%)
Control	5.89	-	4.57	77.52	5.65	-	4.24	75.00
Ammonium nitrate	13.21	124.28	10.97	83.06	11.32	100.35	9.08	80.14
Ammonium nitrate + ammonium sulphate (1:1 w/w)	11.60	96.94	9.45	80.47	10.01	77.35	8.14	81.33
Rhizobacterin	8.45	43.41	7.26	85.97	8.67	53.45	7.33	84.50
Nitrobein	9.35	58.74	8.41	89.96	9.39	66.19	7.98	85.00
Biogene	6.51	10.53	5.50	84.42	6.32	11.86	5.39	85.32
Microbein	8.84	50.08	7.45	84.23	8.64	52.92	7.31	84.65
FYM	9.40	59.59	8.50	90.43	8.52	50.80	7.59	89.08
L.S.D at 5%	0.88	4.53	0.80	4.75	0.49	2.13	0.41	4.36

Table (2): Effect of mineral-, bio- and organic fertilizers on some chemical constituents of potato tubers in 2007 growing season (on dry weight basis).

Chemical constituents (%) / Treatments	Reducing sugars (RS) %	Non-reducing sugars (NRS) %	Total sugar (T.S) %	Starch content %	Total crude protein (N × 5.7) %	Crude fat %	Total ash content %	Total crude fibers
Control	0.33	1.35	1.68	76.00	6.13	1.08	4.55	6.96
Ammonium nitrate	0.14	2.03	2.16	72.88	8.31	0.74	9.34	4.22
Ammonium nitrate + ammonium sulphate (1 : 1 w/w)	0.13	1.67	1.80	70.38	9.76	0.78	9.52	5.56
Rhizobacterin	0.08	2.32	2.40	77.58	7.35	0.78	5.64	3.75
Nitrobein	0.09	2.99	3.04	76.14	7.00	0.94	5.49	4.11
Biogene	0.12	1.64	1.76	76.90	7.88	1.10	5.63	4.85
Microbein	0.07	1.93	2.00	78.07	7.88	0.76	4.23	4.96
FYM	0.18	1.78	1.96	76.95	6.90	1.34	5.47	5.12
L.S.D at 5%	0.18	1.34	1.07	1.87	1.73	0.79	1.44	1.20

Table (3): Effect of mineral-, bio- and organic fertilizers on quality of potato tubers during 2007 growing season.

Treatments / Quality	Dry matter content (%)	Vitamin C (ascorbic acid) content (mg/100 g f.w.)	NO_3 content (mg / kg d.w.)
Control	19.55	12.37	294.10
Ammonium nitrate	16.23	12.81	340.26
Ammonium nitrate + ammonium sulphate (1 : 1 w/w)	17.45	13.54	335.16
Rhizobacterin	25.10	15.97	232.20
Nitrobein	25.75	16.78	224.54
Biogene	24.59	16.60	237.52
Microbein	25.19	16.22	242.00
FYM	24.35	15.70	199.54
L.S.D at 5%	1.39	0.59	0.52

Table (4): Effect of frying process on chemical constituents of potato tubers grown in 2007 season (%, on dry weight basis).

Fertilizers / Chemical constituents (%)	Total carbohydrates				Crude protein (N × 5.7)	Crude fat	Total ash	Crude fibres
	Reducing sugars	Non-reducing sugars	Total sugars	Starch				
Control (unfertilized)	0.27^{a}	1.65^{g}	1.92^{c}	58.80^{e}	4.73^{c}	18.98^{b}	3.45^{c}	6.08^{a}
Ammonium nitrate	0.07^{cd}	2.30^{d}	2.37^{bc}	57.65^{f}	6.21^{ab}	26.24^{a}	7.64^{a}	3.50^{e}
Ammonium nitrate + ammonium sulphate (1 : 1 w/w)	0.08^{c}	1.87^{f}	1.95^{c}	55.58^{g}	7.15^{a}	24.35^{a}	7.47^{a}	4.73^{b}
Rhizobacterin	0.05^{d}	2.56^{b}	2.62^{b}	61.88^{a}	5.74^{bc}	13.26^{cd}	4.75^{b}	3.15^{g}
Nitrobein	0.07^{cd}	3.30^{a}	3.37^{a}	59.94^{d}	5.60^{bc}	12.34^{d}	4.64^{b}	3.41^{f}
Biogene	0.09^{c}	2.40^{c}	2.49^{bc}	60.65^{c}	6.23^{ab}	14.04^{cd}	4.76^{b}	4.01^{d}
Microbein	0.05^{d}	2.25^{de}	2.30^{bc}	61.77^{b}	6.18^{ab}	13.14^{cd}	3.49^{c}	3.99^{d}
FYM	0.12^{b}	2.15^{e}	2.27^{bc}	58.75^{e}	5.52^{bc}	14.83^{c}	4.58^{b}	4.47^{c}
L.S.D at 5%	0.02	0.14	0.59	0.633	1.12	2.103	0.95	0.063

Table (5): Interactive effects of both pre-soaking and cooking on nitrate reduction in cooked potatoes.

Soaking treatments \ Fertilization treatments	Control (unfertilized)	% loss	Ammonium nitrate alone	% loss	Ammonium nitrate + ammonium sulphate (1 : 1 w/w)	% loss	Rhizobacterin	% loss	Nitrobein	% loss	Biogene	% loss	Microbein	% loss	FYM	% loss
Raw material	294.1^{a}	-	340.26^{a}	-	335.16^{a}	-	232.20^{a}	-	224.54^{a}	-	237.52^{a}	-	242.0^{a}	-	199.54^{a}	-
Control (distilled water)	80.92^{bc}	72.49^{f}	71.65^{d}	78.94^{d}	63.86^{d}	80.95^{c}	44.55^{d}	80.81^{d}	34.62^{d}	84.58^{d}	35.16^{d}	85.20^{d}	54.70^{d}	77.39^{c}	46.13^{c}	76.88^{f}
0.5% Citric acid	41.25^{g}	85.97^{bc}	39.42^{h}	88.41^{b}	38.66^{g}	88.47^{b}	18.41^{h}	92.07^{b}	21.06^{h}	90.62^{b}	20.66^{h}	91.30^{b}	25.92^{g}	89.29^{b}	19.53^{g}	90.21^{c}
0.5% $CaCl_2$	97.82^{b}	66.74^{g}	118.1^{b}	65.29^{f}	112.07^{b}	66.56^{e}	71.08^{b}	69.39^{f}	73.62^{b}	67.21^{f}	78.82^{b}	66.81^{f}	78.65^{b}	67.50^{d}	64.17^{b}	67.84^{g}
2.0% NaCl	74.51^{d}	74.67^{e}	82.31^{c}	75.81^{e}	74.78^{c}	77.69^{d}	49.89^{c}	78.51^{e}	48.54^{c}	78.38^{e}	56.40^{c}	76.26^{e}	56.66^{c}	76.59^{c}	46.1^{d}	76.90^{f}
0.5% Citric acid + 0.5% $CaCl_2$	56.66^{e}	80.73^{d}	46.76^{f}	86.26^{c}	43.18^{e}	87.12^{b}	25.33^{f}	89.09^{c}	23.51^{f}	89.53^{bc}	28.21^{f}	88.12^{c}	27.10^{f}	88.80^{b}	29.10^{e}	85.41^{e}
0.5%Ascorbic acid	39.56^{h}	86.55^{b}	48.22^{e}	85.83^{c}	38.22^{h}	88.60^{b}	24.91^{g}	89.27^{c}	22.12^{g}	90.15^{b}	28.05^{g}	88.19^{c}	30.04^{e}	87.59^{b}	25.01^{f}	87.47^{d}
0.5% Citric acid + 0.5% Ascorbic acid	44.88^{f}	84.74^{c}	46.58^{g}	86.31^{c}	42.90^{f}	87.20^{b}	25.65^{e}	88.95^{c}	26.50^{e}	88.20^{c}	29.01^{e}	87.78^{c}	27.32^{f}	88.71^{b}	14.84^{h}	92.56^{b}
0.5%Sodium metabisulfite	32.38^{i}	88.99^{a}	27.23^{i}	91.99^{a}	20.12^{i}	93.99^{a}	4.31^{i}	98.14^{a}	6.01^{i}	97.32^{a}	7.72^{i}	96.75^{a}	6.50^{h}	97.31^{a}	8.89^{i}	95.54^{a}
L.S.D at 5%	0.059	1.72	0.015	1.51	0.015	1.42	0.012	1.54	0.016	1.56	0.011	1.42	0.57	1.70	0.002	1.26

Table (6): Interactive effects of both pre-soaking and processing on nitrate reduction in French fries.

Fertilization treatments / Soaking treatments	Control (unfertilized)	% loss	Ammonium nitrate alone	% loss	Ammonium nitrate + ammonium sulphate (1 : 1 w/w)	% loss	Rhizobacterin	% loss	Nitrobein	% loss	Biogene	% loss	Microbein	% loss	FYM	% loss
Raw material	294.1^{a}	-	340.26^{a}	-	335.16^{a}	-	232.20^{a}	-	224.54^{a}	-	237.52^{a}	-	242.00^{a}	-	199.53^{a}	-
Control (distilled water)	69.49^{d}	76.37^{d}	93.69^{b}	72.47^{d}	89.51^{b}	73.29^{f}	37.71^{e}	83.76^{c}	34.74^{e}	84.53^{d}	37.75^{e}	84.11^{d}	38.92^{e}	83.92^{d}	35.24^{d}	82.34^{e}
0.5% Citric acid	38.23^{g}	87.00^{ab}	26.03^{g}	92.35^{a}	24.17^{g}	92.79^{b}	11.73^{h}	94.95^{a}	15.21^{h}	93.23^{b}	12.81^{h}	94.61^{ab}	16.21^{g}	93.30^{b}	12.02^{h}	93.98^{ab}
0.5% $CaCl_2$	84.91^{b}	71.13^{f}	83.40^{c}	75.49^{c}	79.94^{c}	76.15^{e}	52.13^{b}	77.55^{d}	46.62^{b}	79.24^{e}	51.40^{b}	78.36^{e}	54.57^{b}	77.45^{f}	39.47^{b}	80.22^{e}
2.0% NaCl	75.99^{c}	74.16^{e}	77.72^{d}	77.16^{c}	70.08^{d}	79.09^{d}	47.^{86c}	79.39^{d}	46.50^{c}	79.29^{e}	47.38^{c}	80.05^{e}	50.51^{c}	79.13^{e}	37.93^{bc}	80.99^{e}
0.5% Citric acid + 0.5% $CaCl_2$	35.14^{h}	88.05^{a}	27.12^{f}	92.03^{a}	23.46^{h}	93.00^{b}	14.82^{g}	93.62^{a}	17.57^{g}	92.18^{b}	18.33^{g}	92.28^{b}	15.91^{g}	93.43^{b}	15.47^{g}	92.25^{bc}
0.5%Ascorbic acid	34.03^{i}	88.43^{a}	23.83^{h}	93.00^{a}	25.11^{f}	92.51^{b}	31.02^{f}	86.64^{b}	28.63^{f}	87.25^{c}	28.29^{f}	88.09^{c}	30.25^{f}	87.50^{c}	18.94^{f}	90.51^{c}
0.5% Citric acid + 0.5% Ascorbic acid	62.75^{e}	78.66^{c}	60.80^{e}	82.13^{b}	57.15^{e}	82.95^{c}	37.96^{d}	83.65^{c}	37.05^{d}	83.50^{d}	39.26^{d}	83.47^{d}	41.14^{d}	83.00^{d}	25.15^{e}	87.40^{d}
0.5%Sodium metabisulfite	42.39^{f}	85.59^{b}	19.23^{i}	94.35^{a}	14.48^{i}	95.68^{a}	10.55^{i}	95.46^{a}	8.94^{i}	96.02^{a}	9.55^{i}	95.98^{a}	9.28^{h}	96.17^{a}	10.47^{i}	94.75^{a}
L.S.D at 5%	0.06	1.59	0.01	2.16	0.01	1.64	0.03	1.99	0.01	2.33	0.002	2.59	0.57	1.44	0.002	2.33

Table (7): Interactive effects of both pre-soaking and processing on nitrate reduction in potato chips.

Fertilization Treatments / Soaking treatments	Control (unfertilized)	% loss	Ammonium nitrate alone	% loss	Ammonium nitrate + ammonium sulphate (1 : 1 w/w)	% loss	Rhizobacterin	% loss	Nitrobein	% loss	Biogene	% loss	Microbein	% loss	FYM	% loss
Raw material	294.10^{a}	-	340.26^{a}	-	335.16^{a}	-	232.20^{a}	-	224.54^{a}	-	237.52^{a}	-	242.0^{a}	-	199.54^{a}	-
Control (distilled water)	80.88^{d}	72.50^{d}	80.05^{c}	76.47^{e}	75.14^{c}	77.58^{f}	48.34^{c}	79.18^{f}	47.27^{c}	78.95^{f}	48.58^{c}	79.55^{e}	47.57^{c}	79.93^{bc}	59.07^{b}	70.40^{f}
0.5% Citric acid	50.233^{g}	82.92^{c}	44.06^{g}	87.05^{c}	39.17^{g}	88.31^{c}	30.53^{f}	86.93^{c}	28.76^{g}	87.19^{c}	27.32^{g}	88.50^{c}	23.89^{g}	90.13^{ab}	25.40^{g}	87.27^{c}
0.5% $CaCl_2$	95.14^{b}	67.65^{e}	53.14^{e}	84.38^{d}	55.56^{d}	83.43^{e}	44.19^{d}	80.92^{e}	42.28^{d}	81.17^{e}	37.31^{d}	80.08^{e}	41.74^{d}	82.75^{bc}	38.42^{d}	80.75^{d}
2.0% NaCl	85.44^{c}	70.95^{d}	86.77^{b}	74.50^{f}	82.45^{b}	75.41^{g}	57.39^{b}	75.28^{g}	54.50^{b}	75.73^{g}	56.22^{b}	76.33^{f}	59.41^{b}	75.45^{c}	50.59^{c}	74.65^{e}
0.5% Citric acid + 0.5% $CaCl_2$	52.50^{f}	82.15^{c}	47.40^{f}	86.07^{c}	43.07^{f}	87.15^{c}	29.60^{g}	87.25^{c}	29.82^{f}	86.72^{c}	29.41^{f}	87.62^{c}	27.27^{f}	88.73^{c}	23.73^{h}	88.11^{c}
0.5%Ascorbic acid	25.77^{i}	91.24^{a}	30.39^{h}	91.07^{b}	26.78^{h}	92.01^{b}	9.92^{h}	95.73^{b}	18.24^{h}	91.88^{b}	13.90^{h}	94.15^{b}	14.88^{h}	93.85^{ab}	14.95^{i}	92.51^{b}
0.5% Citric acid + 0.5% Ascorbic acid	53.47^{e}	81.82^{c}	56.59^{d}	83.37^{d}	50.34^{e}	84.98^{d}	35.01^{e}	84.92^{d}	33.25^{e}	85.19^{d}	36.70^{e}	84.55^{d}	38.28^{e}	84.18^{abc}	26.05^{f}	86.95^{c}
0.5%Sodium metabisulfite	37.94^{h}	87.10^{b}	14.12^{i}	95.85^{a}	10.69^{i}	96.81^{a}	3.95^{i}	98.30^{a}	4.09^{i}	98.18^{a}	6.68^{i}	97.19^{a}	6.53^{i}	97.30^{a}	28.25^{e}	97.85^{a}
L.S.D at 5%	0.059	1.93	0.010	1.42	0.015	1.42	0.0017	1.30	0.013	0.85	0.002	1.20	0.57	12.88	0.057	1.53