Zamzam Water-Induced Changes in Growth and Biochemical Parameters in Lentils

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Abstract: Irrigation of lentil seedlings with different amounts of Zamzam water increased the rate of germination substantially. Root and shoot length were elongated by Zamzam irrigation. The increase in root length was higher than shoot length. There was increase in the fresh weight and decrease in the dry weight with increase the amount of Zamzam water. Irrigation with Zamzam water increased the protein and RNA content. However, the results demonstrated an activation effect of Zamzam-induced on overall growth in lentil. Among the biochemical parameters analyzed, protein, DNA, total phenolic compounds and total antioxidant contents were enhanced.

Key words: Zamzam water, chemical analysis, lentils growth.

INTRODUCTION

Agricultural sciences take an interest not only in the common and valued crop-forming factors, but also in those less expensive and generally underestimated though more pro-ecological ones (Abdul Qudos and Hozayam, 2010). Influence of some abiotic factors, such as As and Cd (Jain and Gadre, 1997 and Jain et al., 2007), osmotic or water stress (Lei et al., 2009), and salts (Parvaiz and Satyavati, 2008), on growth and metabolism of plants has been intensively studied. Drought-induced osmotic stress triggers a wide range of perturbations ranging from growth and water status disruption to the modification of ion transport and uptake systems (Bajji et al., 2000 and Jain et al., 2010).

Lentil (Lens culinaris L.) is one of the prominent sources of plant protein after soybean in the world. Lentils are an excellent source of complex carbohydrates and dietary fiber as well as a good source of high quality protein, vitamins and minerals (Adsule et al., 1989). Despite being nutritious and healthy, legumes including lentils are underutilized in developed countries (Schneider, 2002 and Joshi, 2010).

It is well known that Zamzam water existed from old time at Makkah in KSA since Prophet Abraham, and used for drinking. The amount of Zamzam water to consume by people visiting Makkah for pilgrimage is increasingly high (Mutwally et al., 2008). Zamzam is present in Makkah, Saudi Arabia which contains multiminerals such as Ca, Mg, S, Fe, Mn and Cu (Mutwally and Al-Sayaad, 2002). This well is considered to be the most famous well in the Islamic world. Muslims, from all walks of life, visit the well to drink, to seek cure, to do their ablution and wash. This, in fact, makes plenty of this water goes to the sewage system. Because of that, the need arises to invest this huge amount of water in agriculture, where some plants can be grown either as food crops or as useful street trees especially at holy places such as Arafat and Mina places (Hamed et al., 2009).

Mutwally et al. (2008) studied the effect of Zamzam water as irrigating water on some growth parameters of wheat and broad bean plants and they found that Zamzam water improved those estimated parameters. Also, Hamed et al. (2009) the effect of Zamzam water, in comparison with well water (already used in irrigation) and desalinized water (as control), on some parameters of the yield quality of two of the most famous crops; broad bean (Vicia faba L.) and wheat (Triticum vulgare L.).

The present study was aimed to investigate the effect of Zamzam water, in comparison with Tape water (as control), on growth and biochemical parameters in Lentils.

MATERIALS AND METHODS

Analysis of water:

Zamzam water and Tape water was analyzed on Unit UMR Qualisud at CIRAD (Center for International Cooperation in Agronomic Research for Development). The minerals were estimated by atomic absorption instrument in the LAB.

Plant material:

Sterilized seeds of Lentil (Lens culinaris M.) were raised in continuous light for 7–8 days at 25 ± 2°C. They were watered with half strength Hoagland’s solution containing 5mM NH₄NO₃. To analyze growth parameters, sterilized lentils seeds were grown on filter paper placed in Petri plates and irrigated with varying amounts of Zamzam water (0.0) (Tape water), 25%, 50, 75, 100%). At 25 ± 3°C in continuous light supplied with fluorescent tubes for 8 days.
Total protein:  
Protein content was estimated with Folin-Ciocalteau reagent according to the method of Lowry et al. (1951).

Total DNA and RNA:  
Total DNA was estimated by the methods of Labarca and Paigen (1980). Total RNA was estimated by the method of Webb and Levy (1958) using orcinol reagent.

Total soluble phenolic compounds:  
Total soluble phenolic content of methanolic extracts was assayed as described by Cevallos-Casals and Cisneros-Zevallos (2003) using Folin-Ciocalteau reagent with final reaction measurements conducted at 725 nm. Total phenolics were expressed as mg chlorogenic acid equivalents (CAE) 100 g⁻¹ wet basis (WB), based on a standard curve.

Total antiradical capacity (TAC):  
TAC of phenolic compounds was adapted from Brand-Williams et al. (1995). The same methanol extract as for phenolic was used. The presented data are the average values of at least three replicate experiments with ± S.E. Student’s t-test was applied to test the significance of difference obtained for various treatments.

RESULTS AND DISCUSSION

Zamzam water contained many important nutritive elements such Ca, Mg, K, Fe, Cu, Nitrates, P, S, Ammonia, Zn and Mn more than in tap water. Each element has its nutritive values (Table 1). The pH of zamzam water is more than tap water. Taiz and Zeiger (2006). On the other hand, it had more harmful elements than tap water such as Na, nitrates, Cl, F and Pb. Although the concentrations of these elements were relatively low and within the safety range Mutwally and Al-Sayaad (2002), this presence may be controlled by the presence of other elements which either retard their absorption or their bad effect. In this connection, K may retard Na (Rush and Epstein, 1981); K may retard Cl (Bloom and Finazzo, 1986); Ca may retard Na (Hamed, 2000) and Ca may retard F (Kauss, 1983). In the case of the Pb, the presence of both K (Sluiter et al., 1977) and P (Axelsen and Palmgren, 2001), may retard its toxicity (Hamed et al., 2009).

The results of the present investigation demonstrate the effect in growth parameters of lentil seedlings imposed by different concentration of Zamzam water. The treatment of lentil seeds with 75% and 100% Zamzam has higher the germination rate after 3 days of germination; however, there was 0% (Figs. 1 & 2). Other growth parameters affected by osmotic stress are root and shoot lengths with the shoot length being decreased more than the root length (Fig. 3). Incubation of leaf segments with different concentrations of Zamzam water increased the fresh weight in a concentration-dependent manner, but increased the dry weight (Fig. 4).

Experimental stress could evoke compensatory metabolic changes through modification and modulation of the quantity and quality of proteins (Ramagopal, 1987). A concentration-dependent increase in protein and DNA content with increase Zamzam water in the present study (Table 2) could be due to decreased proteolysis and increased protein synthesis, respectively, which increased the total amount of biosynthesized proteins. Low protease activity of water-stressed maize plants compared to control plants was reported by Thakur and Thakur (1987). These contents were increased in Zamzam water application more than well water application, while desalinized water recorded the least contents. The effect of the nutritive elements, DNA and protein biosynthesis may be explained through the effective roles of each element. Bloom and Finazzo (1986) reported that ammonia stimulated the metabolic rate of nitrates resulting in increase of protein content in barley plants. Taiz and Zeiger (2006) discussed suggested that the increasing of amino acids and protein may be due to the enhancement effect of K on the biosynthesis of RNA. Rufty et al. (1990) stated that amino acids and protein contents were increased because P increased the bioconversion of nitrate into amino acids. Goldgur et al. (2007) pointed to the role of Zn in the mechanism of changing protein from unfolded to folded state which led to an increase in the protein biosynthesis. Reduction in RNA content was also observed with increasing concentration of Zamzam water (Table 2). Increase RNA synthesis with increased Zamzam watersuggested downregulation of chloroplast RNAase as one of the possible reason for the degradation of RNA. Furthermore, many researchers showed that the ribosomes and the proportion of polyribosomes decreased remarkably during water stress (Scott et al., 1979 and Mason et al., 1988).

The values of total phenolics and TAC for a dry or dormant seed would indicate the amount of phenolic antioxidants synthesized while the seed was attached to the parent plant, while for imbibed seed and 7d sprout the total phenolics and TAC values indicate synthesis of phenolic antioxidants after dormancy (Cevallos-Casals and Cisneros-Zevallos, 2010). In the present study showed that increase amount of Zamzam water increase the phenolic compound and total antioxidant.
In general, Zamzam water has benefit effects for plants irrigation near Makka lands due not only to the type of the nutrient existed in the water but also on the ratio between these nutrient which acted as synergetic agents for useful nutrients or antagonistic agents for harmful elements to retard their harmful effects.

**Fig. 1:** Effect of different concentrations of Zamzam water on the growth of Lentil seeds after 6 days.

**Fig. 2:** Effect of different amounts of Zamzam water on germination rate of lentil seeds after 3 days germination.

**Fig. 3:** Effect of different amounts of Zamzam water on root and shoot length in maize seedlings.
Fig. 4: Effect of different amounts of Zamzam water on lentil fresh and dry weights.

Table 1: Comparative analysis of Zamzam water and tap water.

<table>
<thead>
<tr>
<th>Elements of analysis</th>
<th>Zamzam water</th>
<th>Tap water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Conductivity</td>
<td>1069.00 µS/cm</td>
<td>444.00 µS/cm</td>
</tr>
<tr>
<td>pH</td>
<td>8.10 mg/l</td>
<td>7.57 mg/l</td>
</tr>
<tr>
<td>Ca</td>
<td>72.51 mg/l</td>
<td>70.30 mg/l</td>
</tr>
<tr>
<td>Mg</td>
<td>18.25 mg/l</td>
<td>6.30 mg/l</td>
</tr>
<tr>
<td>K</td>
<td>50.99 mg/l</td>
<td>1.24 mg/l</td>
</tr>
<tr>
<td>Na</td>
<td>114.49 mg/l</td>
<td>20.21 mg/l</td>
</tr>
<tr>
<td>Fe</td>
<td>0.01 mg/l</td>
<td>&lt;0.01 mg/l</td>
</tr>
<tr>
<td>Al</td>
<td>0.01 mg/l</td>
<td>0.01 mg/l</td>
</tr>
<tr>
<td>Mn</td>
<td>0.00 mg/l</td>
<td>&lt;0.01 mg/l</td>
</tr>
<tr>
<td>N-NH4</td>
<td>0.10 mg/l</td>
<td>0.04 mg/l</td>
</tr>
<tr>
<td>Cl</td>
<td>152.20 mg/l</td>
<td>56.50 mg/l</td>
</tr>
<tr>
<td>S-SO4</td>
<td>38.91 mg/l</td>
<td>6.26 mg/l</td>
</tr>
<tr>
<td>N-NO3</td>
<td>10.80 mg/l</td>
<td>0.71 mg/l</td>
</tr>
<tr>
<td>P-PO4</td>
<td>0.01 mg/l</td>
<td>0.01 mg/l</td>
</tr>
<tr>
<td>HCO3</td>
<td>296.46 mg/l</td>
<td>224.48 mg/l</td>
</tr>
<tr>
<td>Si</td>
<td>15.16 mg/l</td>
<td>2.22 mg/l</td>
</tr>
</tbody>
</table>

Table 2: Biochemical parameters on different amount of germinated lentil seeds treated with different amounts of Zamzam water.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>0%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein (mg/g tissue)</td>
<td>14.40</td>
<td>25.20</td>
<td>30.30</td>
<td>34.2</td>
<td>37.1</td>
</tr>
<tr>
<td>Total DNA (µg/g tissue)</td>
<td>809.13</td>
<td>1965.00</td>
<td>2974.78</td>
<td>3376.0</td>
<td>3670.0</td>
</tr>
<tr>
<td>Total RNA (µg/tissue)</td>
<td>4614.25</td>
<td>3344.28</td>
<td>3165.68</td>
<td>3125.4</td>
<td>3022.5</td>
</tr>
<tr>
<td>Total phenolics (mg/g tissue)</td>
<td>0.60</td>
<td>1.10</td>
<td>1.40</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Total antioxidant (μg trolox/g tissue)</td>
<td>8.00</td>
<td>14.70</td>
<td>18.20</td>
<td>22.7</td>
<td>25.2</td>
</tr>
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REFERENCES


