

Some Physiological Parameters of the Yields of *Vicia faba* L. and *Triticum vulgare* L. Irrigated with Zamzam, Desalinized or Well Water.

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Abstract: Broad bean (*Vicia faba* L. var. Giza 2) and wheat (*Triticum vulgare* L. var. Sakha 93) were grown on artificial soil and were irrigated with zamzam, desalinized or well water. In case of both plants, Zamzam water improved the growth and activated their physiological and biochemical activities as it recorded the highest values of yield criteria, soluble carbohydrates, total carbohydrates, amino acids (individual and total), protein, total nitrogen contents, fatty acids, lipids and mineral composition (N, P, K, Ca, Mg, S and Fe). Well water recorded moderated results, while desalinized water (as control) recorded the lowest values. Results were discussed according to mineral contents of the used water.

Key words: Broad bean (*Vicia faba* L.) • Wheat (*Triticum vulgare* L.) • Zamzam water • Desalinized water • Well water • Artificial soil • Yield criteria • Carbohydrates • Amino acids • Proteins • Fatty acids • Lipids • Mineral composition

INTRODUCTION

Food shortage and deficiency is considered to be one of the most extremely global and dramatic problems across the world. FAO recorded that about 10-15% of world population does not obtain its enough food requirements [1]. So scientists should exert a lot of effort to increase food production in terms of quality and quantity so that a radical solution is found.

Vicia faba L plant is considered as one of the most popular and cheapest protein source [2, 3], while *Triticum vulgare* L is considered as one of the most common source of carbohydrate food stuff [4, 5].

Zamzam well is a water well located in Makkah, Saudi Arabia, which contains multi-minerals such as Ca, Mg, S, Fe, Mn and Cu [6]. 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 different agricultural aspects, where some plants can be grown either as food crops or as useful street trees especially at holly places such as Arafat and Mina (holy pilgrimage places around Makka). In this connection many studies were carried out to

investigate the effect of different mixtures of zamzam water as irrigating water on some growth parameters of wheat and broad bean plants [7] and they found that zamzam water improved those estimated parameters.

The aim of this work was to investigate 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 broad bean (*Vicia faba* L.) and wheat (*Triticum vulgare* L.) plants.

MATERIALS AND METHODS

Broad bean seeds (*Vicia faba* L.var. Giza 2) and wheat grain (*Triticum vulgare* L. var. Sakha 93) were kindly provided by Field Crops Research Institute, Agricultural Research Center (ARC), Giza, Egypt. The experiment was carried out in a glass house on the roof of the Community College, Baha University, Baha, Kingdom of Saudi Arabia (KSA). It was designed by dividing the experiment into three groups; first group was irrigated with zamzam water, second group was irrigated with desalinized water and third group was irrigated with well water. The irrigation was 100% field capacity in all treatments. Field capacity was calculated at 7 am daily [8]. Each type of this used water was analyzed [6]. Each group

Table 1: The general properties of the soil used to compare the effect of zamzam, desalinated or well water on the yield of *Vicia faba* and *Triticum vulgare*

Item	Value
Nitrogen (N)	2.1%
Phosphorous (P ₂ O ₅)	2.7%
Potassium (K ₂ O)	1.1%
Magnesium (Mg)	1.2%
Iron (Fe)	1.2%
Manganese (Mn)	247 mg/kg
Zinc (Zn)	11 mg/Kg
Copper (Cu)	40 mg/Kg
Organic matter	65-75%
Moisture content	35 – 55%
pH	5.5 -6.5
EC	1.5 – 1.8 m mohs/cm

was divided into two subgroups; the first subgroup was cultivated with broad bean seeds while the second subgroup was cultivated with wheat grains. Cultivation was done in black plastic bags (25 cm diameter x 40 cm height). Each bag was filled up to 2/3 (with net weight 250 g) with artificial organic soil produced by Truf Enterprise Company, Germany. The data of the soil properties was tabulated in Table 1. Each bag was cultivated with 5 uniformly seeds. Each subgroup had 30 replicates. At the sixth week, all treatments, according

to the recommended doses, were fertilized with (1.57 g K₂HPO₄ + 0.785 g K₂SO₄) [1]. At the end of the experiment, each subgroup was divided randomly into six sets each set contained five replicates. The first set was used for investigation of the morphological yield criteria. The second set was used for carbohydrate analysis [9]. The third set was used for determination of the amino acids; either totally [10] or individually [11]. The fourth set was used for determination of total protein [12]. The fifth set was used for determination of the total fatty acids [13] and for determination of total lipids [14]. The sixth group was used for estimation of some elements of the yield seeds [15]. The estimation was carried out at Occupational Health Department, National Institute of Occupational Safety and Health (NIOSH), Cairo, Egypt. The estimated elements were N, P, K, Ca, Mg, S and Fe and they were estimated by using Perkin Elmer 3030 atomic absorption. All obtained results were subjected to least significant difference (LSD) test [16].

RESULTS AND DISCUSSION

Data in Table 2 showed that, zamzam water contains many important nutritive elements such as Ca, Mg, K, Fe, Cu, nitrates, P, S, ammonia, Zn and Mn, which have their nutritive values. On the other hand, it has some harmful elements such as Na, nitrites, Cl, F and Pb. The

Table 2: Some properties of the three types of the used water

Item	Zamzam water	Desalinated water	Well water	LSD _{1%}	LSD _{5%}
pH	6.970	6.840	7.920	0.451	0.326
Conductivity Ms/cm	1597.160	219.000	523.670	108.030	78.120
Total hardness (ppm)	360.330	20.000	76.550	10.030	7.250
Total alkalinity (ppm)	29.830	19.670	45.890	6.360	4.600
Calcium (ppm)	112.170	4.620	20.440	3.080	2.220
Magnesium (ppm)	22.450	2.260	7.480	3.630	2.620
Potassium (ppm)	38.830	0.000	3.500	1.910	1.380
Sodium (ppm)	53.000	0.000	41.130	4.660	3.370
Iron (ppm)	0.0015	0.020	0.170	0.004	0.003
Copper (ppm)	24.320	0.005	0.059	0.193	0.267
Chlorides (ppm)	175.010	9.880	80.270	1.500	1.090
Fluorides (ppm)	0.820	0.000	0.220	0.004	0.003
Nitrates (ppm)	97.900	0.190	3.950	1.330	0.960
Nitrites (ppm)	0.279	0.0040	0.0123	0.006	0.005
Phosphate (ppm)	0.2535	0.0013	0.0035	0.006	0.005
Sulphates (ppm)	270.420	0.000	15.630	3.930	2.840
Ammonia (ppm)	0.0013	0.002	0.460	0.050	0.030
Zinc (ppm)	0.130	0.003	0.531	0.250	0.180
Lead (ppm)	0.002	0.006	0.011	0.003	0.002
Manganese (ppm)	<0.070	<0.070	<0.070	---	---
Cadmium (ppm)	<0.025	<0.025	<0.025	---	---
Chromium (ppm)	<0.130	<0.130	<0.130	---	---
Bicarbonates (ppm)	388.000	46.670	61.110	10.550	7.630
Total suspended solids (ppm)	0.233	0.030	12.670	1.010	0.730
Total dissolved salts (ppm)	781.000	7.330	241.170	38.690	27.980

Table 3: Effect of the irrigation with zamzam, desalinated or well water on some criteria of the yield of *Vicia faba* and *Triticum vulgare*

Parameter	Item	<i>Vicia faba</i>	<i>Triticum vulgare</i>
Fruit length (cm)	Zamzam water	7.80	11.90
	Desalinated water	5.40	8.20
	Well water	6.30	9.60
	LSD _{5%}	0.55	0.71
	LSD _{1%}	0.70	0.90
No of fruit/plant	Zamzam water	3.70	12.60
	Desalinated water	2.40	7.40
	Well water	3.10	10.20
	LSD _{5%}	0.26	1.66
	LSD _{1%}	0.33	2.11
No of seed/plant	Zamzam water	13.20	49.00
	Desalinated water	7.40	29.00
	Well water	9.80	39.00
	LSD _{5%}	0.90	6.71
	LSD _{1%}	1.14	8.51
Wt of 1000 seeds (g)	Zamzam water	612.63	42.08
	Desalinated water	413.52	27.12
	Well water	534.79	33.81
	LSD _{5%}	48.38	1.79
	LSD _{1%}	61.34	2.27

Table 4: Effect of the irrigation with zamzam, desalinated or well water on some carbohydrate fractions (mg/g d wt) of the yield of *Vicia faba* and *Triticum vulgare*

Treatment	<i>Vicia faba</i>		<i>Triticum vulgare</i>	
	Soluble carbohydrate	Total carbohydrate	Soluble carbohydrate	Total carbohydrate
Zamzam water	384.014	681.642	562.412	822.415
Desalinated water	304.281	524.624	342.815	512.835
Well water	352.875	581.452	429.068	634.714
LSD _{5%}	25.889	41.821	15.502	22.260
LSD _{1%}	32.821	53.018	32.112	46.112

concentrations of these elements are relatively low and within the safety range [6]. The presence of such harmful elements may be controlled by the presence of other elements which either retard their absorption or antagonize their bad effects. In this connection, K may retard Na [17]; K may retard Cl [18]; Ca may antagonize Na [19]; and Ca may retard F [20]. In case of the Pb, its toxicity may be retarded by the presence of K [21] or by presence of P [22].

Data tabulated in Table 3 showed that, the estimated yield criteria were significantly affected by the type of the water used. Zamzam water recorded the best criteria values, followed by well water while, desalinated water recorded the lowest criteria values. Addition of macro- and micronutrients to plants may lead to improve their yield properties [23]. As desalinated water had the lowest concentrations of these nutrients, it gave the lowest yield criteria. Well water gave a medium yield criteria and this may be due to containing a medium nutritional concentration.

The effect of the used water types on the soluble and total carbohydrate fractions was shown in Table 4. It is noticeable that these fractions were significantly changed due to the type of water used and zamzam water recorded the maximum enhancement occurred in these fractions. Some studies discussed such enhancement as a result of the activation occurred in the photosynthetic rate which may be activated by ammonia [24], by Cu [25], by Mn [26] or by S [27]. Other studies referred such effect to the enhancement in the photosynthetic pigments either by Fe [28], P [29] or by Mn [23]. The increase in the carbohydrate fractions may also be referred to the activity occurred in the carbohydrate metabolism by the effect of K [30], P [31] or by Ca [19].

The estimated amino acids and protein contents are displayed on tables 5, 6 a and 6 b. These values were increased in zamzam water application more than well water application, while desalinated water recorded the least contents. The effect of the nutritive elements on amino acid and protein biosynthesis may be explained

Table 5: Effect of the irrigation with zamzam, desalinized or well water on total amino acids and total protein (mg/g d wt) of the yield of *Vicia faba* and *Triticum vulgare*

Treatment	<i>Vicia faba</i>		<i>Triticum vulgare</i>	
	Total amino acids	Total protein	Total amino acids	Total protein
Zamzam water	44.287	287.173	30.116	214.311
Desalinized water	29.782	234.112	19.537	158.426
Well water	30.479	215.125	24.701	192.115
LSD _{5%}	1.905	6.556	1.699	10.339
LSD _{1%}	2.416	8.311	2.154	13.108

Table 6-a: Effect of the irrigation with zamzam, desalinized or well water on the individual amino acids ($\mu\text{g/g d wt}$) of the yield of *Vicia faba*

Amino acid	Zamzam water	Desalinized water	well water	LSD _{5%}	LSD _{1%}
Glycine	0.281	0.181	0.202	0.035	0.048
Alanine	1.031	0.651	0.832	0.056	0.076
Valine	0.169	0.109	0.123	0.038	0.052
Leucine	4.177	2.641	2.966	0.031	0.042
Isoleucine	4.354	2.751	3.091	0.028	0.036
Phenylalanine	1.823	1.152	1.294	0.034	0.046
Proline	0.669	0.423	0.475	0.045	0.062
Tryptophane	0.004	0.003	0.003	0.043	0.058
Serine	0.086	0.054	0.061	0.028	0.036
Therionine	0.136	0.086	0.097	0.031	0.041
Methionine	0.337	0.213	0.239	0.021	0.028
Aspergine	8.616	5.445	6.117	0.007	0.010
Glutamine	1.618	1.023	1.149	0.024	0.033
Aspartic acid	1.121	0.708	0.796	0.038	0.052
Glutamic acid	0.319	0.201	0.226	0.054	0.073
Tyrosine	0.092	0.058	0.065	0.029	0.040
Cysteine	0.124	0.136	0.153	0.060	0.082
Histidine	1.942	1.227	1.379	0.040	0.061
Lysine	6.466	4.086	4.791	0.025	0.034
Arginine	12.941	8.177	9.188	0.156	0.213

Table 6-b: Effect of the irrigation with zamzam, desalinized or well water on the individual amino acids ($\mu\text{g/g d wt}$) of the yield of *Triticum vulgare*

Amino acid	Zamzam water	Desalinized water	well water	LSD _{5%}	LSD _{1%}
Glycine	0.583	0.365	0.414	0.027	0.037
Alanine	0.284	0.182	0.202	0.043	0.059
Valine	2.972	1.879	2.111	0.023	0.032
Leucine	2.981	1.884	2.117	0.023	0.032
Isoleucine	2.641	1.668	1.875	0.021	0.029
Phenylalanine	1.072	0.669	0.761	0.026	0.035
Proline	0.561	0.354	0.398	0.035	0.048
Tryptophane	0.101	0.064	0.072	0.033	0.045
Serine	0.243	0.154	0.173	0.023	0.031
Therionine	0.042	0.029	0.031	0.023	0.032
Methionine	0.103	0.066	0.073	0.016	0.022
Aspergine	6.385	4.035	4.533	0.236	0.321
Glutamine	0.078	0.048	0.055	0.018	0.025
Aspartic acid	0.093	0.059	0.066	0.029	0.039
Glutamic acid	1.134	0.715	0.805	0.040	0.055
Tyrosine	0.235	0.144	0.167	0.022	0.030
Cysteine	0.123	0.078	0.087	0.011	0.015
Histidine	0.141	0.093	0.105	0.030	0.040
Lysine	4.065	2.568	2.886	0.018	0.025
Arginine	9.938	6.283	7.056	0.114	0.158

Table 7: Effect of the irrigation with zamzam, desalinated or well water on total fatty acids and total lipids (mg/g f wt) of the yield of *Vicia faba* and *Triticum vulgare*

Treatment	<i>Vicia faba</i>		<i>Triticum vulgare</i>	
	Total fatty acids	Total lipids	Total fatty acids	Total lipids
Zamzam water	1.42	19.121	1.724	23.213
Desalinated water	0.84	9.142	0.93	12.356
Well water	1.07	14.235	1.33	17.984
LSD _{5%}	0.23	1.737	0.25	2.373
LSD _{1%}	0.29	2.168	0.31	2.962

Table 8: Effect of the irrigation with zamzam, desalinated or well water on N (as mg/g d wt), P, K, Ca, Mg, S and Fe (as p p m) of the yield of *Vicia faba* and *Triticum vulgare*

Treatment	N		P		K		Ca		Mg		S		Fe	
	Broad		Broad		Broad		Broad		Broad		Broad		Broad	
	bean	Wheat	bean	Wheat	bean	Wheat	bean	Wheat	bean	Wheat	bean	Wheat	bean	Wheat
Zamzam water	211.4	132.5	1.954	1.554	1.411	0.964	0.052	0.038	0.492	0.382	0.286	0.234	1.837	1.554
Desalinated water	181.2	113.2	1.675	1.328	1.209	0.824	0.042	0.031	0.422	0.326	0.245	0.201	1.575	1.328
Well water	198.5	125.6	1.835	1.473	1.324	0.914	0.047	0.034	0.462	0.363	0.269	0.224	1.724	1.471
LSD _{5%}	2.766	2.578	0.300	0.020	0.052	0.021	0.005	0.004	0.024	0.112	0.087	0.006	0.047	0.036
LSD _{1%}	3.456	3.221	0.024	0.016	0.042	0.017	0.004	0.003	0.019	0.009	0.007	0.005	0.038	0.029

through the effective roles of each element participating in their biosynthesis. Ammonia may stimulate the metabolic rate of nitrates causing an increase in total amino acids and protein content in barley plants [18]. The positive effect of Cu may be due to it increases metallothioneins biosynthesis and its distribution [32]. Manganese may increase amino acids biosynthesis through increasing superoxide dismutases enzyme [33]. The increasing of amino acids and protein may be due to the enhancement effect of K on the biosynthesis of RNA [23]. Amino acids and protein contents may be also increased because P increased the bioconversion of nitrate into amino acids [34]. On the other hand, S may stimulate protein biosynthesis through stimulating the conversion of organic sulfur compounds into S- containing amino acids [35]. The role of Zn in the mechanism of changing protein from unfolded to folded state may lead to an increase in the protein biosynthesis [36].

Table 7 showed the data of total fatty acids and lipids of the two tested plants due to application of the three types of water used. These fractions were positively responded to the treatment applied. Zamzam water gave the best results while desalinated water gave the lowest values. The increment caused by zamzam water may be explained due to the positive effect of P role in nucleoprotein biosynthesis and/or ATP biosynthesis [23]. An increase in fatty acids and total lipids due to Ca application was observed in many studies and was attributed to the activation in their metabolism [19].

The general activation occurred in the plant biosynthesis may be due to the activation occurred in the photosynthetic efficiency as a result of the application of S element [27].

The concentration of some macro- and micronutrient in the yield of the two tested plants are presented in Table 8. Zamzam water recorded the best criteria values, followed by well water while desalinated water recorded the lowest criteria values. There is a positive relationship between the mineral concentration accumulated inside the plant and the concentration applied externally during mineral nutrition course [17] and this positive relationship is also obvious in these data.

Generally, the difference occurred in the value of each estimated parameter between broad beans and wheat plants can be explained due to the difference of their species. This result was in agreement with the results obtained by other studies and may be referred to the activation occurred in process of the absorption and translocation. Accumulation of the nutrients depends not only on the species of the plant but also on the genotype of the same species [18, 37].

Finally, the benefits obtained by application of zamzam water may be due not only to the type of the nutrient existed in the water but also on the ratio between these nutrients which acted as synergetic agents for useful nutrients or antagonistic agents for harmful elements to ameliorate their harmful effects. At the end, this work was a trial to throw light on the importance and the benefits of zamzam water.

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