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Effect of red beetroot (*Beta vulgaris* L.) intake on the level of some hematological tests in a group of female volunteers

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The plant kingdom constitutes a source of new chemical compounds which may be important owing to their potential use in medicine and other applications. This study discussed the effect of taking 8 g of beetroot (*Beta vulgaris* L.) for 20 days on the blood samples of female volunteers where the hemoglobin levels before and after the study was recorded. The results showed mild increase in hemoglobin readings, decrease in total iron binding capacity (TIBC), increase in ferritin and decrease in transferrin. Also, there was mild increase in serum iron levels after taking beetroot. Regarding MCV, it showed mild increase in four volunteers only. However, more research is needed to clearly identify mechanisms of action and proper dosing patterns to maximize the performance benefits of beetroot.

Key words: Beetroot, *Beta vulgaris* L., iron.

INTRODUCTION

In different parts of the world especially in Africa and Asia with high incidence of the disease, the people have learnt to manage the problem using plants which are God's gift of nature. Various advances in scientific research on the use of plants and herbs brought the beneficial aspects of traditional medicine and the rational for their uses to the limelight (Okpuzor et al., 2008). Different beetroot compounds, for example betalains, became especially important for phytomedicine: betalains (betacyanins and betaxanthines) have been detected only in red-violet, orange and yellow pigmented botanical species belonging to closely related families of the order caryophyllalles (Kujala et al., 2000). Betalain pigments have specifically been shown to possess various antioxidant functions (Escribano et al., 1998).

Anemia in association with iron deficiency has serious implications in terms of increased morbidity and mortality rates in vulnerable groups, impaired growth and cognitive abilities in children, and reduced capacity and poor obstetric performance in adults (Soewondu et al., 1989). Although many causes of anemia have been identified worldwide (Fleming, 1981), it is agreed that nutritional

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deficiency is due primarily to low bioavailability of dietary iron accounts for more than half the total number of cases (Skikne,1988). Hemoglobin determination is one of the most convenient screening methods in anemia. Of the iron status indicators, serum ferritin (SF) and erythrocyte protoporphyrin (EP) are among the reliable indexes available for assessing nutrition in population groups (Kuvibidila et al., 1994).

Red beet (*Beta vulgaris* L.) is cultivated throughout the world for its roots, which are used as a food and as a source of natural dye (Chevallier, 1996). Beets are small herbaceous plants with broad dark green leaves. Beetroot is one of the richest sources of folate. Beetroot is also a source of fiber, potassium, manganese, iron, vitamin C, and a number of other vitamins and minerals (Rauha et al., 2005). Results from several *in vitro* studies have demonstrated that betalains from beetroots possess powerful antiradical and antioxidant activity (Kujala et al., 2002). Medicinally, the roots and leaves of the beet have been employed as a folk remedy to treat a wide variety of ailments (Kapadia et al., 2003).

Besides other active chemicals, beetroots contain a unique class of water-soluble, nonphenolic antioxidants, the betalains, including two classes of compounds, red betacyanins (principally betanin) and yellow betaxanthines (Kanner et al., 2001). The aim of the present study was to show up the impact of Beetroot (*Beta vulgaris* L.) intake on the level of some blood tests in a group of female volunteers.

In recent years, the root vegetable *B. vulgaris* rubra, otherwise known as red beetroot (herein referred to as beetroot) has attracted much attention as a health promoting functional food. Reports of its use as a natural medicine date back to Roman times (Ninfali and Angelino, 2013). Today, beetroot is grown in many countries worldwide, is regularly consumed as part of the normal diet, and commonly used in manufacturing as a food colouring agent known as E162 (Georgiev et al., 2010; Zielińska-Przyjemska et al., 2009).

Recent studies have provided compelling evidence that beetroot ingestion offers beneficial effects for several pathologies, such as; hypertension, atherosclerosis, type 2 diabetes and dementia (Ninfali and Angelino, 2013; Gilchrist et al., 2014; Presley et al., 2011; Vanhatalo et al., 2010; Wootton-Beard et al., 2011). Hypertension in particular has been the target of many therapeutic interventions and there are numerous studies that show beetroot, delivered acutely as a juice supplement (Bailey et al., 2009; Webb et al., 2008; Jajja et al., 2014) or in bread (Hobbs et al., 2013; Hobbs et al., 2012) to significantly reduce systolic and diastolic blood pressure. Further discussion of beetroot's anti-hypertensive potential is summarised in several reviews (Hobbs et al., 2013; Kapil et al., 2014 and Lidder and Webb, 2013).

Beetroot supplementation might serve as a useful strategy to strengthen endogenous antioxidant defenses (Kannan and Jain, 2000; Kohen and Nyska, 2002). Beetroot is as an exceptionally rich source of antioxidant compounds. The betalain pigments in particular, has been shown to protect cellular components from oxidative injury (Kanner et al., 2001; Reddy et al., 2005; Tesoriere et al., 2008). For example, in the study by Kanner et al. (2001), two betalain metabolites (betanin and betanidin) were shown to reduce linoleate damage induced by cytochrome C oxidase and lipid membrane oxidation induced by H_2O_2-activated metmyoglobin and free iron (AA-Fe). The authors also reported that betanin, the most abundant betalain found in beetroot (300 to 600 mg kg^{-1}), was the most effective inhibitor of lipid peroxidation.

Beetroot contains several highly bioactive phenolics, such as rutin, epicatechin and caffeic acid which are also known to be excellent antioxidants (Georgiev et al., 2010; Frank et al., 2005; Manach *et al*., 2005). Furthermore, nitrite and other NO donors akin to beetroot have been shown to suppress radical formation and directly scavenge potentially damaging Reactive oxygen and nitrogen species (RONS) (Lundberg et al., 2011; Wink et al., 2001 and Wink et al., 2011).

A number of studies report that beetroot, in the form of a juice supplement, protects against oxidative damage to DNA, lipid and protein structures *in vitro* (Pietrzkowski et al., 2010; Kujawska et al., 2009; Winkler et al., 2005). A study by Wootton-Beard and Colleagues suggests that a key mechanism by which beetroot juice exerts its antioxidant effects is by scavenging radical species (Wootton-Beard et al., 2011). They found that two commercially available beetroot juices inhibited *in vitro* radical formation in the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 3-ethylbenzothiazoline-6-sulfonicacid ABTS assays by 100 and 92%, respectively. The antioxidant capacity of beetroot juice is comparable to or higher than a variety of fruit and vegetable juices (Wootton-Beard et al., 2011; Ryan and Prescott, 2010). Interestingly, the antioxidant capacity of beetroot juice in both the (DPPH) and FRAP assays was far greater than more well-known vegetable juices.

MATERIALS AND METHODS

Plant

Red beetroot (*B. vulgaris* L.) was purchased from a local market in Makkah, Saudi Arabia.

Preparation of dried beetroot

Red beetroots were washed with tap water, chopped into small pieces and then dried. The dried material was reduced into powder form as far as possible.

Subject

Seven apparently healthy female volunteers (age range, 22 to 24

Table 1. Hemoglobin (Hb), total iron binding capacity (TIBC), ferritin (Fe), transferrin (Tf), serum iron(SI) and mean corpuscular volume (MCV) values before and after red beetroot (*Beta vulgaris* L.) supplementation.

Volunteers number	Hb		TIBC		Ferritin		Transferrin		S. Iron		MCV	
	12-16 g/dL*		228-428 ug/dL*		20-150 ng/dL*		200-360 mg/dL*		37-145 ug/dL*		80-97 fL*	
	A	B	A	B	A	B	A	B	A	B	A	B
1	13.8	14.2	325	319	36.1	37.4	275	270	40	72	88.1	86.4
% of change	2.9% +		1.8% -		3.6% +		1.8% -		80.0% +		1.9% -	
2	11.2	11.7	440	411	3.5	4.1	372	348	14	27	80.3	79.6
% of change	4.5% +		6.6% -		14.7% +		6.5% -		92.9% +		0.9% -	
3	12.4	12.7	339	335	33.5	47.0	287	284	22	42	78.1	79.2
% of change	2.4% +		1.2% -		40.3% +		1.0% -		90.9% +		1.4% +	
4	12.9	13.5	361	356	14.7	17.5	306	302	42	82	85.2	85.9
% of change	4.7% +		1.4% -		19.3% +		1.3% -		95.2% +		0.8% +	
5	10.5	11.7	405	367	20.5	26.0	343	311	41	81	72.6	75.5
% of change	11.4% +		9.4% -		26.8% +		9.3% -		97.6% +		4.0% +	
6	12.0	12.7	372	352	4.6	5.0	315	298	28	54	97.3	97.1
% of change	5.8% +		5.4% -		8.7% +		5.4% -		92.9% +		0.2% +	
7	11.0	11.4	461	395	9.9	10.3	391	335	74	110	84.2	83.7
% of change	3.6% +		14.3% -		3.9% +		14.3% -		48.6% +		0.6% -	

* Normal Rang.

years) received oral dried beetroot 20 days; 8 g of dried beetroot was given to each in the morning.

Study design

The iron status of the subjects was assessed at onset of the study (sample A) by assaying a venous blood sample for hemoglobin, total iron binding capacity ,serum ferritin, serum transferrin, mean cell volume and serum iron. Similar tests were also performed after the discontinuation of supplementation (sample B). Blood samples were taken at private laboratory in the city of Makkah.

Blood samples were withdrawn from every volunteer and placed in test tubes which contain anticoagulant substance. First test tube was utilized to do complete blood count by UDI hemolysis machine, and the second test tube was placed in central centrifugation to isolate the plasma and then to analyze ferritin, transferrin and total iron binding capacity separately by MINE Vidas machine. Iron levels in serum were analyzed by CUBAS C3.

RESULTS AND DISCUSSION

Table 1 shows the result of laboratory investigations for hemoglobin (Hb), total iron binding capacity (TIBC), ferritin (Fe), transferrin (Tf), serum iron (SI) and mean corpuscular volume (MCV) from blood samples of the subjects tested before the experiment and after 20 days of taking 8 g of beetroot in a daily basis. Table 1 and Figure 1 show clearly that there was a mild increase in Hb levels of the subjects after taking beetroot and the increase percentage was ranged between 2.4 and 11.4%. The findings of the study are consistent with the study conducted by Gayathri Priya et al. (2013) and on the other hand, the levels of TIBC decreased for all subjects after taking beetroot in relation to pre-test levels, and the percentage for the decrease ranged between 1.2 and 14.3% as in Table 1 and Figure 2; this decrease in TIBC may be related to improvement of iron store as a result of beetroot intake.

Ferritin levels for all subjects showed up mild

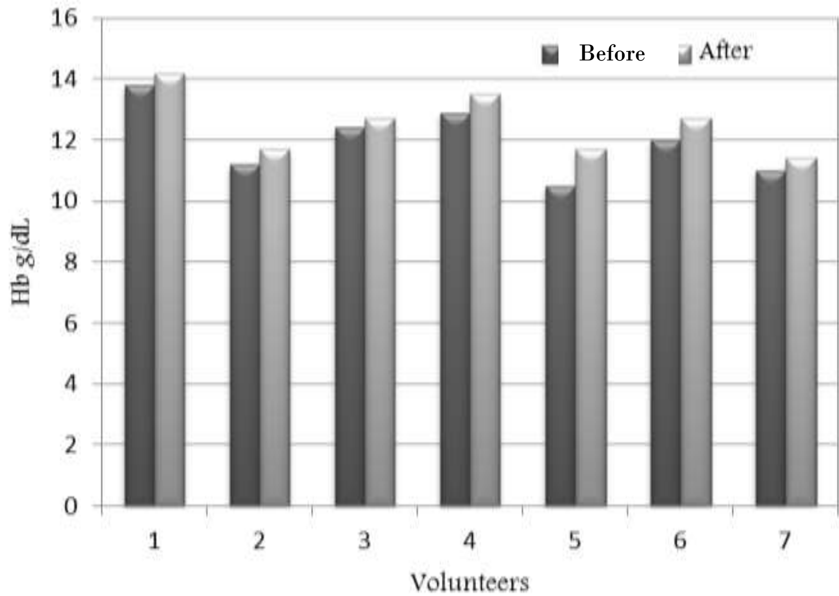

Figure 1. Hemoglobin (Hb) values before and after red beetroot (*Beta vulgaris* L.) supplementation.

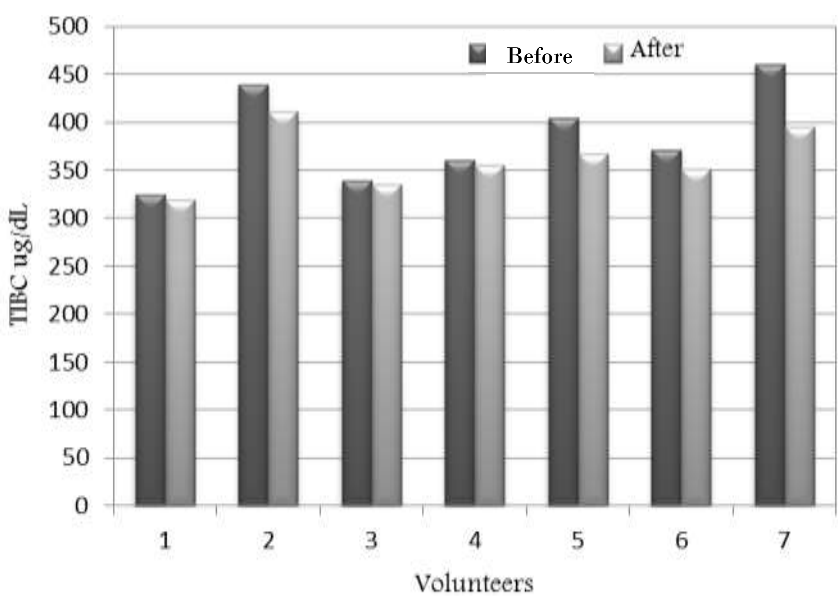

Figure 2. Total Iron Binding Capacity (TIBC) values before and after Red beetroot (*Beta vulgaris* L.) supplementation.

increase after 20 days of taking beetroot in relations to the levels that have been recorded before the test and the increase percentage was ranged between 3.6 and 40.3% as in Table 1 and Figure 3. Ferritin has normally been considered as a storage compound from which iron is readily mobilized, so this increase in Fe may be related to improvement of iron store as a result of beetroot intake. Under steady state conditions, serum ferritin concentrations correlate well with total body iron stores. Thus, serum ferritin is the most convenient laboratory test to estimate iron stores (Wood et al., 2005; Nadadur et al., 2008; Hunt et al., 2009). On the other hand, transferrin

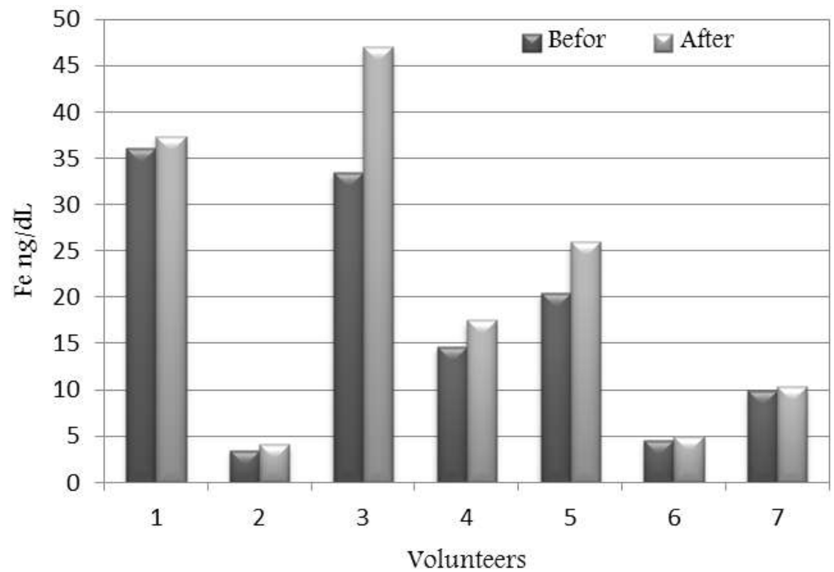

Figure 3. Ferritin (Fe) values before and after Red beetroot (*Beta vulgaris* L.) supplementation.

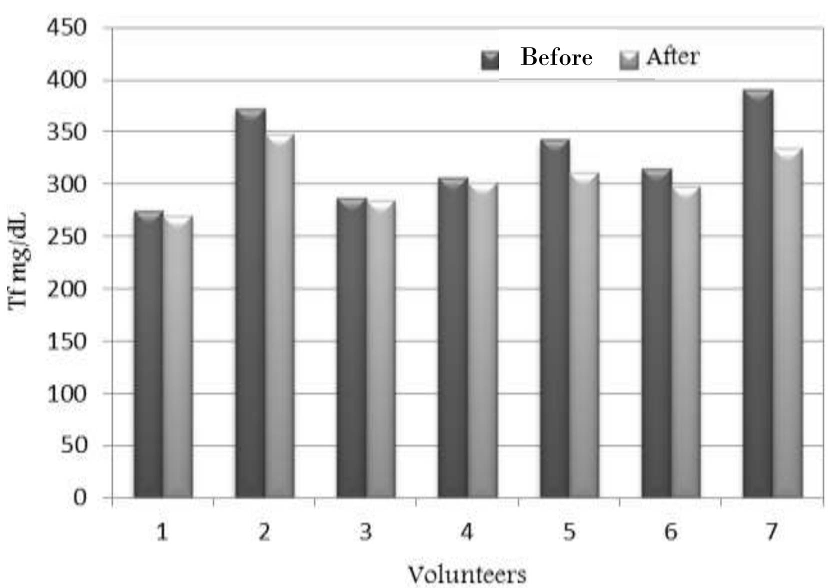

Figure 4. Transferrin (Tf) values before and after red beetroot (*Beta vulgaris* L.) supplementation.

levels decreased in blood samples of the subjects after 20 days of taking beetroot in comparison to the levels that have been recorded before the test as in Table 1 and Figure 4 and the decrease percentage was ranged between 1 and 14.3%. The decrease in transferrin level may be as a result of decrease for iron demand.

Serum iron levels at all subjects showed up enormous increase after taking beetroot and the levels recorded were 80, 92.9, 90.9, 95.2, 97.6, 92.9 and 48.6% respectively as in Table 1 and Figure 5. This probably indicates that beetroot is an excellent source of iron. Also, MCV levels showed up mild increase at four subjects after taking beetroot and the increase percentages were 1.4, 0.8, 4 and 2% respectively as it

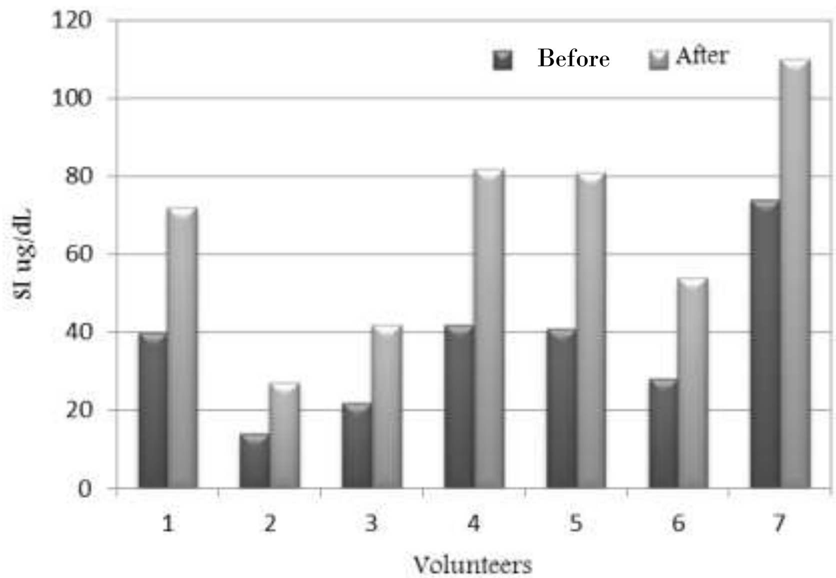

Figure 5. Serum iron (SI) values before and after Red beetroot (*Beta vulgaris* L.) supplementation.

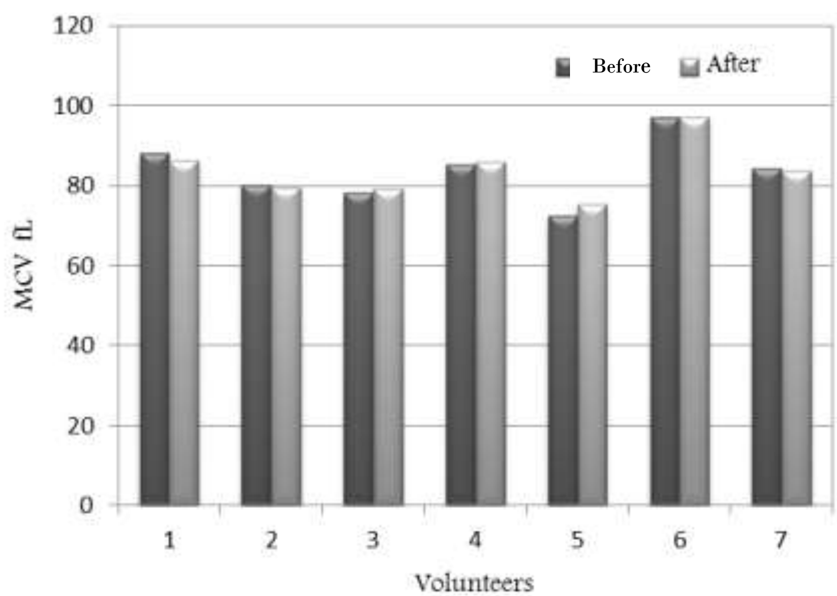

Figure 6. Mean corpuscular volume (MCV) values before and after Red beetroot (*Beta vulgaris* L.) supplementation.

appears in Table 1 and Figure 6. This may be related to the fact that 20 days are not sufficient to have a satisfactory results regarding MCV level and we need a bit longer duration. Also, it is may be explained by the length of RBC life span which takes approximately 120 day (Harrison, 1979). Indhumathi and Kannikaparameswari (2012) stated that *B. vulgaris* recorded significant increase in packed cell volume (PCV), hemoglobin concentration, Red Blood Cell counts (RBCs), and total lymphocyte count and MCV.

Anemia in association with iron deficiency has serious implications (Soewondu et al., 1989; Beard and Connor, 2003). Iron depletion is the earliest stage of iron deficiency. Iron-deficiency anemia is the most advanced stage of iron deficiency. It is characterized by decreased or absent iron stores, low serum iron concentration, low transferrin saturation, and low blood hemoglobin concentration (Kenneth et al., 2010). Hemoglobin determination is one of the most convenient screening methods in anemia. Of the iron status indicators, serum ferritin (SF) and erythrocyte protoporphyrin (EP) are among the reliable indexes available for assessing nutrition in population groups (Kuvibidila et al., 1994). Beetroot is one of the richest sources of folate, which is important for a healthy heart and for women trying to conceive, as it helps prevent spinal cord defects in the baby. Beetroot is also a source of other substances and minerals (Rauha et al., 2005).

In this study, we recorded obvious increase in serum iron level, mild increase in hemoglobin and ferritin after taking 8 g of beetroot for 20 days and thus it can be stated that beetroot might have some therapeutic properties for iron deficiency. So, it is suggested that beetroot be put within the dietary protocols for women at childbearing age after doing more advanced studies in this regard.

CONFLICT OF INTERESTS

The author has not declared any conflict of interest

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