Nutritional, Sensory and Biological Study of Biscuits Fortified With Red Beet Roots

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Abstract: The use of red beet roots powder and extract in the preparation of biscuits and the effect of consumption of these biscuits on injured liver in experimental rats were studied. The results revealed that beet powder orbeet extractincorporation to biscuits increased protein and ash contents as well as fiber, moisture contents and caloric value. Biscuit fortified with beet extract showed higher sensory values in comparing with biscuit with beet powder. Biological study was carried on forty male rats which administered 0.5 ml/rat /by back subcutaneous of CCl4 in paraffin oil for two days from the start of the experimental period for inducing rats liver injury. Rats were classified into control (+ve) group, control biscuit group, beet powder biscuit group and beet extract biscuit group. The experimental period was 45 days. Biscuit with beet powder and biscuit with beet extractrat groups showed a significant increase in body weight gain and FER and liver antioxidant enzymesbut showed a significant decrease in liver function enzymes in serum and liver cholesterol and total lipids compared with both control (+ve) and control biscuit rat groups. This study investigated that addition of red beet root to biscuits increase nutritional values and acceptability, and also showed improvement of liver function enzymes and antioxidant in injured liver rats.
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Key wards: Biscuit- red beet roots-liver injury – rats.

1.Introduction

Biscuits are a mixture of flour and water but contain fat, sugar and other ingredients mixed together into dough which is rested for a period and then passed between rollers to make a sheet **(Okaka 1997)**. Biscuits are the most popular bakery items consumed nearly by all levels of society because of low cost among other processed foods, good nutritional quality and availability in different varieties with longer shelflife. Most of bakery products are used as a source for incorporation of different nutritionally rich plants**(Hooda and Jood 2005)**.

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. Beets are small herbaceous plants with broad dark-green leaves. Its underground taproot matures in 50-60 days of sowing and weighs about 100 to 150 g. The unique crimson-red color of red beet is due tobetalainpigments, such as*betanin*and *betacyanin*. Yellow varieties are rich in *ß-xanthin*pigment. Beet pigments, betalains, have been examined as natural colorants in food products such as processed meat, ice cream, baked goods, candies, and yogurt. Beetroot is a rich source of potent nutrients including magnesium, sodium, potassium and vitamin C., andbetaine.Results from several *in vitro* studies have demonstrated that betalains from beetroots possess powerful antiradical and antioxidant activity **(Kujala et al. 2002)**.

The objectives of this research work are to identify the proximate composition and the sensory evaluation of biscuits fortified with beetroots powder or extract and also to determine the treatment effect on liver injury in rats.

2.Materials and Methods

A- Materials:

Red beet roots, wheat flour, margrine, egg, sugar, vanilline, salt and baking powderwere purchased from local market in Riyadh, Saudi Arabia. Carbon tetrachloride (CCl_4) purchased from El Gomhorya Co. in the form of 40% liquid dispensed in 1 L plastic bottles which used to induce rat hepatitis at dose 0.5 ml/rat /by back subcutaneous injection according to **Lee et al. (2005) and Abd El-Ghany and Nanees (2010)**. BioMeriuex Kits were purchased from Alkan Co. for Chemicals and Biodignostics. Forty male albino rats of Sprague Dawley strain were provided from experimental animals' center in Medicine collage of King Saudi University in Riyadh. The average weight was 120 ± 10 g. The rat basal diet consisted of 140 g casein (83 % protein), 100 gsucrose,50 g corn oil, 50 g cellulose, 35 g mineral mixture, 10 g vitamin mixture, 1.8 g L-cystine, 2.5 g choline bitartrate and the remainder (610.6 g) corn starch. Diets were formulated according to **Reeves et al. (1993)**.

B- Methods:

Red beet roots were washed with tap water, chopped into small pieces and then separately dried in an air-circulated oven at 40°C to complete dryness. The dried material was separately reduced into powder form as far as possible and added as 5% for preparation of biscuit fortified with beet powder **(AOAC, 1997)**. 270 g of fresh red beet roots were chopped with both 300 ml ethanol by using a blender for 1 min at average speed. The mixture was macerated during 24h at the 4ºC. After that, resulting extract was filtered using a 0.45 µm pore size cellulose acetate membrane filter. The extract was used as 2.5% in preparation of biscuit fortified with beet extract **(Fritsche*et al.* 2002)**. Phenols, flavonoids and flavonols were determined in red beet roots according to **Singleton and Rossi (1965) and Georgiev *et al.*(2010)**.

Control biscuit dough was prepared according to the formula presented in table (1). Powdered sugar, eggs and margarine were creamed in Braun Mixer with a flat beater for 2 minutes at 6 rpm. Water containing salt, baking powder and vanillin was added to the cream and mixed for 5 minutes at 125 rpm to obtain a homogenous cream. Thereafter flour was added slowly to the above cream and was mixed for 2 minutes at 60 rpm to obtain biscuit dough. The dough was sheeted to a thickness of about 3 mm using and cut into round shape using a 45 mm diameter cutter and baked on an aluminum tray in an electric oven at 180°C for 6 minutes. The biscuit was cooled for 30 minutes, packed in polyethylene bags (**Hanan and Rasha** 2012). Fortified biscuits were prepared as control biscuit with adding 5% red beet roots powder or 2.5 % of red beet roots extract in substituted of flour. Moisture, protein, crude fibers,fat content and ash contents were determined according to the method described in the **AOAC (1997).** Total carbohydrates were calculated by difference. Energy value was calculated according to **Livesy (1995)**. Sensory evaluation for the appearance, exterior color, interior color,softness, tender, degree of sweetness, odour, taste, and general acceptability were done by a numerical hedonic scale ranging from 1 to 10. Ten experienced judges participated in the test **(Larmond 1977)**.

Table (1): Composition of control biscuit, biscuit with beet powder and biscuit with beet extract

Samples / Variables	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
Wheat flour	41	36	38.5
Sugar	12	12	12
Salt	0.30	0.30	0.30
Margarine	29	29	29
Egg	14	14	14
Vanillin	1.5	1.5	1.5
Baking powder	2.2	2.2	2.2
Beet powder	-	5	-
Beet extract	-	-	-

All rats were fed on the basal diet for five day for adaptation then were subcutaneously administered a single dose of CCl4 in paraffin oil for two days from the start of the experimental period for inducing rats liver injuries. Rats were classified into control (+ve) group which fed on the basal diet only, control biscuit group which fed on 10% control biscuit in basal diet, beet powder biscuit group which fed on the 10% beet powder biscuit in basal diet and beet extract biscuit group which fed on 10% beet extract biscuit in basal diet.

The food intake was calculated daily and the body weight gain was recorded daily. Food efficiency ratio was determined according to the method of **Chapman et al. (1959)**. After 45 days, rats were fasted overnight then sacrificed to immediately collect blood in clean and dried Wiesserman tubes from the portal vein. The blood samples were centrifuged at 3000 rpm for 15 minutes to obtain serum. Serum (ALT& AST) activity, alkaline phosphatase, gama glutamyle transferase (γGT) and bilirubin were estimated according to **Reitman and Frankel (1957), Kind and King (1954), Henry (1974) and Jendrassik (1938)**, respectively. The liver of sacrificing rats was perfused with 50 to 100 of ice cold 0.9% NaCL solution. Liver cholesterol, total lipids, superoxide dismutase (SOD), glutathione peroxidase (GPX) and catalase were determined according to **Abell *et al.* (1952), Folch *et al.*(1957), Beuchamp andFridovich, (1971), Beuther *et al.* (1987) and Cohen *et al.* (1970)**, respectively.

Collected data were statistically analyzed using one way analysis of variance (ANOVA).Student "t" test was used for significance according to **Artimage and Berry (1987)**.

3. Results and Discussion

Table (2) showed that the values of polyphenols, flavenoids and flavenols in red beet roots were 1.41, 0.88 and 1.24, respectively. These results indicate that red beet roots have good antioxidant properties. Such data are in good agreement with those previously reported by Kapadia *et al.* 2011 who proved that extract of beetroot exhibited chemopreventive and antioxidant. The effect was evident as a significant reduction in tumor incidence, multiplicity, and delay in tumor latency period. **Váli *et al.* (2007)** reported that table beet contains important bioactive agents (betaine and polyphenols), which have a wide range of physiologic effects. **Pal *et al.* 2010** and **Georgiev *et al.* 2010** reported the presence of flavonoids, carbohydrate, betain, neobetain and anthocyanin pigments in *Beta vulgaris* root of phytochemical studies.

The mean value of gross chemical composition and caloric value of control biscuits and biscuits fortified with beet powderor beet extractwere given in table (3). The data revealed that beet powder orbeet extractincorporation to biscuits increased protein and ash contents as well as fiber, moisture contents and caloric value. However, such supplementation decreased carbohydrate content, fat and energy.The difference than control biscuits attributed to chemical composition of red beet root. The chemical composition of red beet roots showed that the values of carbohydrate, protein, fiber, fat, sugar and moisture are9.56, 1.61, 2.8, 0.17, 6.76 and 87.58 in raw. while the values in cocked beet root are 9.96, 1.68, 2.0, 0.18, 7.96 and 87.06 g/100gram. Besides the colour pigments the juice or extract consists of sugars, salts and/or proteins naturally occurring in red beets (**USDA 2013**)

The scores of the flair sensory evaluation of the biscuits produced from control biscuit, biscuit with beet powder and biscuit with beet extract were shown in table (4). In general, a control biscuit was the most accepted by the judges The scores of various sensory were low in fortified biscuits with beet powder or extract compared to control biscuit where the score values of appearance, exterior color, interior color, softness, tenderness, degree of sweetness, odor, taste and general acceptability were lower in comparing with values of control biscuit. On the other side, biscuit fortified with beet extract showed higher values of appearance, exterior color, softness, tenderness, odor, taste and general acceptability in comparing with biscuit with beet powder.The obtained results were in good accordance with **Pedreno and Escribano2001** who recorded that beetroot juice contains colorants that can be divided into two categories of betalains: the red betacyanins and the yellow betaxathines. Betalain is important for cardiovascular health. Betanin, which makes up 95% of the total betacyanins, is more stable in the beetroot extract than in pure chemical form. **Mridula et al. 2009** recorded increased hardness and breaking strength with increased levels of beetroot powder while redness of biscuits increased but lightness decreased with increased levels of beetroot powder in biscuits.

The present results in table (5) showed no significant difference in food intake and weight gain between control (+ve) and control biscuit groups. Biscuit with beet powder and biscuit with beet extract groups showed a significant increase in body weight gain and FER compared to control (+ve) group at $p<0.001$ and also compared to control biscuit group. These results may be due to nutritional values of red beet roots because of an excellent source of folates, carotenoids, flavonoid anti-oxidants, and vitamin A andB-complex vitamins such as niacin, pantothenic acid, pyridoxine and minerals **(Mohammed et al. 2011)**. *Beta vulgaris* var. *rubra* (table beet root) contains several bioactive agents as. betain, betanin, vulgaxanthine, polyphenols, folic acid and different metal elements as Al, B, Ba, Ca, Cu, Fe, K, Mg, Mn, Na, Zn, which act on the various physiological routes **(Blázovics *et al.* 2007).**

Control (+ve) and control biscuit rat groups showed non significant difference in the examined serum enzymes ALT, AST and ALP ($P>0.05$). On the other side, biscuit with beet powder and biscuit with beet extract showed a significant decrease in serum ALT, AST, ALP and γ GT at $P<0.001$ compared with both control (+ve) and control biscuit rat groups as shown in table (6). The obtained results were in accordance with results of **Kapadia *et al.* (2003)** who recorded that red beetroot (*Beta vulgaris* L.) is used as a popular folk remedy for liver and kidney diseases, for stimulation of the immune and hematopoietic systems, and as a special diet in the treatment of cancer. **Pal *et al.* 2010 and Eman 2011** reported that the treatment with ethanolic extract of *Beta vulgaris* caused significant reduction of CCl4 induced elevated serum levels of enzyme activities indicating that, the extract could preserve the normal functional status of the liver. Decrease in the levels of serum AST, ALT and ALP after treatment with *Beta vulgaris* indicated the effectiveness of the extract against CCl4 induced hepatotoxicity. That may be due to presence of its chemical contents.

Biscuit with beet powder and biscuit with beet extract rat groups showed a significant decrease in liver cholesterol and total lipids compared to both control (+ve) and control biscuit rat groups as shown in table (7). This lipid lowering potential of beet root may be due to flavanoids and/or saponins which were found to be the main constituents of beet root and

these findings are in accordance with the earlier studies demonstrating the effect of flavonoids on cholesterol metabolism. Saponins from some medicinal plants reduced the triglycerides and cholesterol levels in rats and also reduced heart diseases. Also, flavonoids are considered as active principles in many medicinal plants and natural products with positive effect on human health **(Wettasinghe *et al.*2002 and Mohammed *et al.* 2011)**. The hepatoprotective activity of beetroot ethanolic extract against CCl4-induced liver injury in rats assessed on the basis of routine serum markers of liver function and the concentration of cholesterol and triglycerides **(Agarwal *et al.* 2006)**.

Control (+ve) and control biscuit rat groups showed a significant increase in liver catalase ($P<0.01$). On the other side, biscuit with beet powder and biscuit with beet extractrat group showed a significant increase in liver SOD, GPX and catalase at $P<0.001$ compared with both control (+ve) and control biscuit rat groups as shown in table (8). The present findings showed that, Betalains of beet root are water-soluble plant pigments that are widely used as food colorants, and have a wide range of desirable biological activities, including antioxidant, anti-inflammatory, hepatoprotective, anti-cancer properties **(Georgiev *et al.*, 2010)**.

Table (2): The content of polyphenols, flavenoids and flavenols (µg/g) of red beet roots

Samples / Variables	Polyphenols	Flavenoids	Flavenols
Red beet roots	1.41	0.88	1.24

Table (3): Gross chemical composition of control biscuit, biscuit with beet powder and biscuit with beet extract

Samples / Variables	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
Carbohydrate	70.81	69.01	69.89
Protein	6.20	6.33	6.26
Fat	16.5	16.35	16.31
Moisture	4.11	4.32	4.13
Ash	1.10	1.31	1.45
Fiber	1.28	2.68	1.96
Energy	456.54	448.51	451.39

Table (4): Sensory evaluation of control biscuit, biscuit with beet powder and biscuit with beet extract

Samples / Variables	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
Appearance	9.11	8.14	8.33
Exterior color	9.01	7.11	7.33
Interior color	8.77	8.55	8.33
Softness	8.55	6.99	7.14
Tenderness	8.71	7.11	7.71
Degree of sweetness	9.14	8.21	7.96
Odour	9.31	6.41	7.55
Taste	9.51	7.55	8.11
General acceptability	9.44	7.50	8.33

Table (5): Mean values ± SD of body weight gain, food intake and FER of the experimental rat groups

Groups / Variables	Control (+ve)	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
Body weight gain(g)	25.14 ± 2.14^{b}	30.41 ± 5.41^{b}	$67.41\pm7.71^{a***}$	$75.71\pm9.01^{a***}$
Food intake (g/w)	15.33 ± 1.25^{a}	15.61 ± 1.31^{a}	16.21 ± 1.21^{a}	17.31 ± 1.31^{a}
FER	0.036 ± 0.001^{d}	$0.043\pm0.002^{c*}$	$0.092\pm0.005^{ab***}$	$0.097\pm0.001^{a***}$

Significant with control (-ve) group * $P<0.05$ ** $P<0.01$ *** $P<0.001$
Mean values in each raw having different superscript (a, b, c, d) are significant

Table (6) The Mean values ± SD of serum ALT, AST, ALP and γ GT of the experimental rat groups

Groups / Variables	Control (+ve)	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
ALT(μ /ml)	103.77±9.61^{a}	95.41±8.81^{ab}	78.61±7.61^{c***}	65.31±7.80^{cd***}
AST(μ /ml)	145.76±12.61^{a}	130.55±13.33^{ab}	81.16±8.20^{c***}	75.41±5.21^{cd***}
ALP(μ /ml)	139.61±13.31^{a}	120.45±14.14^{ab}	92.67±10.21^{c***}	88.14±9.40^{cd***}
γGT(μ /ml)	13.60±1.75^{a}	11.31±1.51^{b*}	7.88±1.33^{c***}	7.31±1.41^{c***}

Significant with control group * P<0.05 ** P<0.01 *** P<0.001
Mean values in each raw having different superscript (a, b, c, d) are significant

Table (7): Mean values ± SD of liver cholesterol and total lipids of the experimental rat groups

Groups / Variables	Control (+ve)	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
Cholesterol	8.11±1.22^{a}	8.41±1.16^{a}	6.31±0.77^{b*}	6.11±0.65^{b*}
Total lipids	49.61±7.33^{a}	46.21±6.96^{ab}	41.71±6.44^{b**}	37.14±6.21^{bc**}

Significant with control group * P<0.05 ** P<0.01 *** P<0.001
Mean values in each raw having different superscript (a, b, c, d) are significant

Table (8): Mean values ± SD of liver SOD, GPX and catalase of the experimental rat groups.

Groups Variables	Control (+ve)	Control biscuit	Biscuit with beet powder	Biscuit with beet extract
SOD (μ /mg)	32.15±3.17^{c}	41.71±5.11^{c}	60.21±7.33^{a***}	60.11±7.20^{a***}
GPX (μ /mg)	29.77±2.91^{b}	35.11±3.96^{b}	58.45±6.11^{a***}	57.71±6.12^{a***}
Catalase (μ /l)	25.11±3.24^{d}	38.41±4.71^{c**}	49.11±5.22^{ab***}	55.61±5.41^{a***}

Significant with control (-ve) group * P<0.05 ** P<0.01 *** P<0.001
Mean values in each raw having different superscript (a, b, c, d) are significant

Conclusion

Biscuits fortified with red beet root powder either powder or extract of acceptable quality were nearly similar to control biscuit. From the study, it was observed that the addition of red beet roots to biscuits blends had better proved to be nutritious functional and healthful foods and also improves liver activity function.

So it is advice to add beet root powder and extract to bakery product and consume it as routine diet to hepatic disease patients.

References

1. Abd El-Ghany, M. A and Y. E.Nanees, 2010. Effect of marjoram leaves on injured liver in experimental rats. Report and Opinion; 2(12):181-191.
2. Abell, L.L., B.B. Levy, B.B. Brodie and I. Kenda, 1952. A simplified method for the estimation of total cholesterol in serum and demonstration of its specificity. J.Biol.Chem.357-366.
3. Agarwal, M., V.K. Srivastava, K.K. Saxena and A. Kumar, 2006. Hepatoprotective activity of Beta vulgaris against CCl4-induced hepatic injury in rats. Fitoterapia, 77 (2): 91-93.
4. AOAC, 1997. Official Methods of Analysis. 16th Ed., Association of Official Analytical Chemists. Arlington-Virginia, USA.
5. Artimage, G.Y and W.G. Berry 1987. Statistical Methods 7th Ed. Ames, Iowa Stata University Press, 39-63.
6. Beuchamp, C. and J. Fridovich, 1971. Superoxide dismutase. Improved assay an assay applicable to acryloamide gels. Anal Biochem. 44: 276-287.
7. Beuther, E., O. Duron, and B. Kelly, 1987. Improved method for the determination of total blood glutathione. J Lab.Clin.24:221-230.
8. Blázovics, A., E.Sárdi, K. Szentmihályi, L. Váli, M. Takács-Hájos and E. Stefanovits-Bányai, 2007. Extreme consumption of Beta vulgaris var. rubra can cause metal ion accumulation in the liver. Acta Biol. Hung.,58(3):281-6.
9. Chapman, D.G., R. Gastilla, and T.A. Campbell, 1950. Evaluation of protein in food. I. A. Method for the determination of protein efficiency ratio. Can. J. Biochem. Physio. I (37) 679-686.
10. Cohen, G., D. Dembuic and J. Marcus, 1970. Measurement of catalase activity in tissue extract. Anal. Biochem., 34, 30–38.
11. Eman A. Sadeek, 2011.Protective effect of fresh juice from red beetroot (Beta vulgaris L.) and radish

(Raphanus sativus L.) against carbon tetrachloride induced hepatotoxicity in rat models. African J. Biol. Sci., 7(1): 69-84.
12. Folch, J, M. lees, and G.H. Stanley, 1957. A simple method for isolation and purification of total lipid from animal tissue. J Biol Chem 266: 497-509.
13. Fritsche, J., C.M. Beindorff, M. Dahtler, H. Zhang and J.G. Lammers, 2002. Isolation, characterization and determination of minor artichoke (Cynara scolymus L.) leaf extract compounds. Eur Food Res Technol, 215:149- 57.
14. Georgiev,V.G., J. Weber, E.M. Kneschke, P.N. Denev, T. Bley and A.I. Pavlov, 2010. Antioxidant activity and phenolic content of betalain extracts from intact plants and hairy root cultures of the red beetroot *Beta vulgaris* cv. Detroit dark red. Plant Foods for Human Nutr., (Formerly Qualitas Plantarum) 65(2): 105-111.
15. Hanan, M. K. and M. A. Rasha, 2012. Nutritional assessment of wheat biscuits and fortified wheat biscuits with citrus peels powders. Food and Public Health, 2(1): 55-60.
16. Henry, R. J., 1974. Clinical Chemistry, Principles and Techniques. 2nd Edition Harper and Row. P. 525.
17. Hooda, S. and S. Jood, 2005.Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. Food Chem, 90, 427–435.
18. Jendrassik, L., 1938. Colorimetric determination of bilirubin. Biochem., 97:72-81.
19. Kapadia, G. J., M. A. Azuine, R. Sridhar, Y. Okuda, A. Tsuruta; E. Ichiishi, T. Mukainake, M. Takasaki, T. Konoshima, H. Nishino and H. Tokuda, 2003. Chemoprevention of DMBA-induced UV-B promoted, NOR-1-induced TPA promoted skin carcinogenesis, and DEN-induced phenobarbital promoted liver tumors in mice by extract of beetroot. Pharmacol Res., Feb; 47(2):141-8.
20. Kapadia, G.J., M.A. Azuine, G.S. Rao, T. Arai, A. Iida and H.Tokuda, 2011. Cytoxic effect of the red beetroot (beta vulgaris l.) extract compared to doxorubicin (Adriamycin) in the human prostate (pc- 3) and breast (mcf-7) cancer cell lines. Anti-Cancer Agents in Medicinal Chemistry, 11 (3), 280-284.
21. Kind, P.R and E. J. King, 1954. Estimation of alkaline phosphatase activity by determination of hydrolyzed phenol with aminoantipyrene. J. Clin.Path.7, 322.
22. Kujala, T.S., M.S. Vienola, K.D. Klika, J.M. Loponen and K. Pihlaja, 2002. Betalain and phenolic compositions of four beetroot (*Beta vulgaris*) cultivars. Eur. Food Res. Technol., 214: 505-510.
23. Larmond, E., 1977. Laboratory Methods for Sensory Evaluation of Food. Canadian Government Publishing Center. Ottawa.
24. Lee, G.P., W.I. Jeong , D.H. Jeong , S.H. Do , T.H. Kim and K.S. Jeong ,2005. Diagnostic evaluation of carbon tetrachloride-induced rat hepatic cirrhosis model. Anticancer Res. Mar-Apr; 25(2A):1029-38.
25. Livesy, G.,1995. Metabolizable energy of macro-nutrients. Am. J. Clin. Nutr. 62 (Suppl.) – 11355-11425.
26. Mohammed, A., A. Saleh, A. Majid, A. Mohammed, M. Nazam and R.Syed 2011. Effect of beta vulgaris on cholesterol rich diet-induced hypercholesterolemia in rats. FARMACIA, 59(5):669:678.
27. Mridula, D., M. N. Kumar, S. K. Tyagi and D. R. Rai, 2009. Effect of addition of beetroot powder on physical properties and acceptability of defatted soya flour fortified biscuits. Indian Journal of Nutrition and Dietetics, 46 (2): 59-69.
28. Okaka, J.C., 1997. Biscuit Manufacture. In cereals and legumes storage and processing Technology. Data and Microsystems Publishers Ltd Enugu. pp 115-130.
29. Pal, R., K.Girhepunje, H. Gevariya, and N. Thirumoorthy, 2010. Hepatoprotective activity of *Beta vulgaris* against CCl4 induced acute hepatotoxicity in rats. Archives of Applied Science Res., 2(1): 14-18.
30. Pedreno, M.A. and J. Escribano, 2001. Correlation between antiradical activity and stability of betanin from Beta vulgaris L. roots under different pH, temperature and light conditions. Journal of the Science of Food and Agriculture, 81: 627-631.
31. Reeves, P.G., F.H. Nielsen and Fahmy, G. 1993. Purified diets for laboratory rodents.Final report of the American Institute of Nutrition.Adhoc wirling committee on the reformation of the Ain-76 rodent diet. J Nutr.123:1939-1951.
32. Reitman,S. and S. Frankel, 1957. Determination of glutamate pyruvate transferase. Amer. J. Clin.Path., 28, 32-33.
33. Singleton, V. L. and J. A. Rossi, 1965. Colorimetry of total phenolics with phosphomolybdic–phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16, 144–158.
34. USDA (2013) National Nutrient Database for Standard Reference, Release 25. Nutrient Data Laboratory Home Pagehttp://www.ars.usda.gov/nutrientdata.
35. Váli, L., E. Stefanovits-Bányai, K. Szentmihályi, H. Fébel, E. Sárdi, A.Lugasi, I. Kocsis, and A. Blázovics, 2007. Liver-protecting effects of table beet (*Beta vulgaris* var. *rubra*) during ischemia-reperfusion. Nutr., 23 (2):172-8.
36. Wettasinghe, M., B. Bolling, L.C. Plhak, H. Xiao and K.L. Parkin, 2002. Phase II enzyme-inducing and antioxidant activities of extracts of beetroot (Beta vulgaris L.). J. Agric. Food Chem, 50, 6704-6709.

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