The Pharma Innovation Journal 2018; 7(4): 414-418

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(4): 414-418

www.thepharmajournal.com
Received: 02-02-2018
Accepted: 03-03-2018

Neha Singh
Ph.D. Scholar, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

John David
Professor, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

DK Thompkinson
Professor Emeritus, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

Blessy Sagar Seelam
Ph.D. Scholar, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

Hridesh Rajput
Ph.D. Scholar, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

Sonia Morya
Ph.D. Scholar, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

Correspondence
Neha Singh
Ph.D. Scholar, Warner College of Dairy Technology, SHUATS, Allahabad, Uttar Pradesh, India

Effect of roasting on functional and phytochemical constituents of finger millet (*Eleusine coracana* L.)

Neha Singh, John David, DK Thompkinson, Blessy Sagar Seelam, Hridesh Rajput and Sonia Morya

Abstract
Finger millet (*Eleusine coracana* L.) is a crop with potentially tremendous but under-explored source of nutraceutical properties as compared to other regularly consumed cereals. Roasting and grinding processes render the grain digestible. On roasting of finger millet it has been observed that it's functional and phytochemical composition such as moisture, fat, protein, phenols and antioxidant activity tends to decrease slightly whereas total carbohydrate content, ash, fibre increases along with the increase in the bio-availability of minerals like calcium and iron. Thus, this study focused on improving the nutritional quality and increasing the bioavailability of nutrients by roasting the millets for nourishing the health and to promote finger millet utilization for future prospective.

Keywords: Finger millet, roasting, bioavailability, nutraceutical, chemical composition

1. Introduction
Millet is one of the oldest food known to humans and possibly the first cereal grain used for domestic purposes. Good nutrition is a fundamental human right. In order to have a healthy population that can promote development, the relation between food, nutrition and health should be reinforced. Finger millet is a fast growing cereal crop that reaches maturity within 3-6 months and sometimes in only 45 days. Finger millet (Eleusine coracana L.) is important millet grown extensively in various regions of India and Africa, constitutes as a staple food for a large segment of the population in these countries. Finger millet, *E. coracana* L. is also known as ragi and *mandua* (India); *kaddo* (Nepal); *fingerhirse* (Germany); *petit mil, eleusine cultivee, coracan, koracan* (France); *bulo* (Uganda); *kambale, lupoko, mawele, amale, bule* (Zambia); *poho, rapoko, zviyo, njera, mazhovole* (Zimbabwe); finger millet, African millet, koracan (England); dagussa, *tokuso, barankiya* (Ethopia); *wimbi, mugimbi* (Kenya). It ranks sixth in production after wheat, rice, maize, sorghum and bajra in India. The acidic methanol extracts from the seed coat showed high antibacterial and antifungal activity.
It is a naked caryopsis with brick red-coloured seed coat and is generally used in the form of the whole meal for preparation of traditional foods, such as roti (unleavened breads or pancake), mudde (dumpling) and ambali (thin porridge). Since the millets are normally prepared from the whole meal, the dietary fiber, minerals, phenolics and vitamins concentrated in the outer layer of the grain or the seed coat form the part of the food and offer their nutritional and health benefits (Antony *et al*., 1996) [3].
Finger millet contains about 5-8% protein, 1-2% ether extractives, 65-75% carbohydrates, 15-20% dietary fiber and 2.5-3.5% minerals (Chethan and Malleshi, 2007) [12]. It has the highest calcium content among all cereals (344 mg/100 g). However, the mill*et al*so contains phytates (0.48%), polyphenols, tannins (0.61%), trypsin inhibitory factors, and dietary fiber, which were once considered as anti nutrients" due to their metal chelating and enzyme inhibition activities but nowadays they are termed as neutraceuticals. The seed coat of the millet is an edible component of the kernel and is a rich source of phytochemicals, such as dietary fiber and polyphenols (0.2-3.0%) (Ramachandra *et al.*, 1977) [28].
Processing affects antinutritional factors such as fibre, phytate and enzyme inhibitors, which in turn can enhance or reduce the bioavailability of micro and macro- nutrients (Nestares *et al*., 1997) [24]. Maximum utilization of the nutrient potential of the millet is limited by the presence of phytates, phenols, tannins and enzyme inhibitors but their effect can be reduced by using processing techniques like popping, roasting, malting and fermentation. Roasting and grinding processes render the grain digestible, without the loss of nutritious components,

(Krantz *et al*., 1983) [21]. The puffing and roasting are almost similar processes, but the volume expansion in puffing is higher (Srivastava *et al*., 1994) [36]. Roasting of cereals, pulses and oilseeds is a simpler and more commonly used household and village level technology which is reported to remove most antinutritional or toxic effects such as trypsin inhibitor, hemagglutinin, gioterogenic agents, cyanogenic glycosides, alkaloids and saponins and increase storage life (Huffman and Martin, 1994) [17].
Weaning foods prepared by roasting of barnyard and finger millet increased iron bioavailability (Gahlawat and Sehgal, 1994) [14]. Bookwalter *et al.* (1987) [7] reported inactivation of lipase in millet flours when roasted at 97ºC. Inactivation of lipase led to minimization of fat hydrolysis. Geervani *et al.* (1996) [15] reported significantly higher net protein utilization (NPU) from roasted millets and legumes mix as compared to dehulled, boiled, malted and baked mixes. Hence an attempt was made to study the effect of roasting on chemical composition and nutraceutical properties of finger millet.

2. Materials and Methods

The whole grain finger millet was procured from local market. The millet was first cleaned, and then roasted. The roasted finger millet was then grounded to fine powder in a home blender for further analysis. The moisture percentage was determined by over drying method as per the procedure given in AOAC (2000) [1] Association of Analytical chemist. The total solids content was estimated by drying the weighed samples to a constant weight in hot air oven at 70$\pm$1ºC. The dried samples were then cooled to room temperature in desiccators prior to weighing (AOAC, 2000) [1]. The fat content was estimated by Solvent extraction method using soxhlet apparatus (AOAC, 2000) [1]. Crude Protein was estimated by Kjeldahl method as per the procedure given in Association of Analytical Chemist, AOAC (2000) [1]. Total carbohydrate was estimated by difference method as per the procedure given in Association of Analytical Chemist, AOAC (2000) [1]. The calcium and iron content was estimated as per the procedure given by Ranganna (2010) [29]. The ash content was determined by charring method as per the procedure given in AOAC (2000) [1] Association of Analytical chemist. The fibre was estimating by simultaneous digestion of defatted sample with dilute sulphuric acid and sodium hydroxide and then filtering through Buchner funnel suction (Sankaran, 1966) [31]. The amount of total phenols in the sample was determined with the Folin-Ciocalteu reagent using catechol as a standard (Bray and Thorpe, 1954) [9]. Antioxidant activity (DPPH free radical scavenging activity) was measured as per the method of Brand-Williams *et al*. (1995) [8].

3. Results and Discussion

3.1 Moisture Content

Moisture content is among the most vital and mostly used measurement in the processing, preservation and storage of food (Onwuka, 2005) [26]. The moisture content has been recorded to decrease from 10.67 to 8.00 per cent in the roasted samples when compared to the unroasted. sample as shown in Figure 1.

3.2 Total Solids (TS)

The total solid content (%) was observed to decrease in roasted finger millet from 89.33 to 92.00 per cent (Fig. 1) when compared to raw finger millet (without roasted) owing to the decrease in the moisture content by the heat treatment given to the samples.

3.3 Total Carbohydrates

The total carbohydrate content in raw (without roasted) and roasted samples was observed as 75.94 and 79.32 per cent respectively (Fig.1). The plant is a good source of carbohydrate when compared with the Recommended Dietary Allowance (RDA) of 130g (Pamela *et al*., 2005) [27]. Total carbohydrate content of finger millet has been reported to be in the range of 72 to 79.5% (Joshi and Katoch, 1990; Bhatt *et al*., 2003) [19, 5, 6]. The carbohydrates include starch as the main constituent being 59.4 to 70.2% (Antony *et al*., 1996; Nirmala *et al*., 2000; Mittal, 2002) [3, 25, 23]. Finger millet starch granules exhibit polygonal rhombic shape. About 80 to 85% of the finger millet starch is amylopectin and remaining 15 to 20% is amylose. Bhatt *et al*. (2003) [5, 6] reported that non-starch polysaccharide account for 20 to 30% of the total carbohydrates in finger millets.

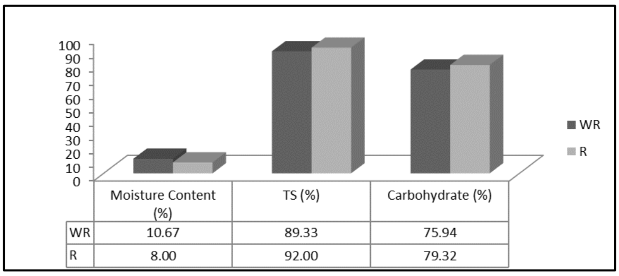

Fig 1: Moisture content, total solids (TS) and total carbohydrate content of without roasted (WR) and roasted (R) finger millet.

3.4 Ash

Ash in food contributes the residue remaining after all the moisture has been removed as well as organic material have been incinerated at a temperature of about 550°C. Ash content is generally taken to be a measure of the mineral content of the original food (Onwuka, 2005) [26]. The data presented in figure 2 shows that there is an increase in the ash content of the roasted sample which was from 3.10 to 4.00 per cent. This increase in the mineral content may be attributed to reduction in phytic acid that might increase the bioavailability of minerals.

3.5 Crude Fibre

An increase in the crude fibre content from 3.90 to 4.20 per cent was observed in the finger millet sample after roasting when compared to the unroasted sample (Fig.2). Same level of fibre (3.7%) has been reported earlier (Joshi and Katoch, 1990) [19]. Kamath and Belavady (1980) [20] found 18.6% dietary fibre and 3.6% crude fibre in finger millet. Crude fibre in food is an indication of the level of non-digestible carbohydrate and lignin. It aids absorption of glucose, poison, fat and also increase fecal sample.

3.6 Crude Fat

The crude fat content in raw (without roasted) and processed (roasted) finger millet was recorded as 1.54 per cent and 1.33 per cent respectively (Fig.2). Decline in fat content upon heat treatment is due to starch lipid complex formation that are resistant to lipid extraction. Low fat content reported in the processed samples is beneficial due to their increased shelf life by decreasing the chances of rancidity (Vadivoo *et al*., 1998) [38]. The crude fat content in finger millet has been reported in range of 1.3 to 1.8% (Bhatt *et al*., 2003) [5, 6] but Antony *et al*. (1996) [3] have reported a higher percentage (2.1%) of crude fat. Sridhar and Lakshminarayana (1994) [35] reported total lipid content in finger millet to be 5.2% (free lipids 2.2%; bound lipids 2.4%; structural lipids 0.6%). The non polar lipid fraction was 80%, glycolipids 6% and phospholipids 14% in finger millet fat. Finger millet though low in fat content, is high in polyunsaturated fatty acids (Antony *et al*., 1996) [3]. The major fatty acid in finger millet was oleic acid followed by palmitic acid and linoleic acid. It had little amount linolenic acid also.

3.7 Protein
A decrease in protein content was observed in raw (without roasted) and roasted finger millet samples i.e. from 8.75 to 7.35 per cent due to protein degradation as shown in Figure 2. Singh and Srivastava (2006) [34] analyzed 16 finger millet varieties and found out that it ranged from 4.88 to 15.58% with a mean value of 9.728%. Prolamin is the major fraction on finger millet protein, being 24.6 to 36.2% of total protein. Antony and Chandra (1998) [2] reported 99.1 mg soluble proteins per 100 g in finger millet. Roasting increases the *in vitro* nitrogen digestion. Protein digestibility is influenced by heating, which renders the protein more susceptible to hydrolysis because of structural changes (Lewis *et al*., 1992) [22].

3.8 Iron
In figure 2, the data shows an increase in the iron content of roasted sample from 3.45 to 3.91 mg/100g as compared to the unroasted sample. Removal of complex polysaccharides of fibrous bran, tannins and phytates during milling improves the bioavailability of iron. The iron content of finger millet ranged from 3.3 to 14.8 mg/100g (Babu *et al*., 1987). Singh and Srivastava (2006) [34] reported the iron content of 16 finger millet varieties ranged from 3.61 mg/100g to 5.42 mg/100g with a mean value of 4.40 mg/100g.

3.9 Calcium
Finger millet is rich in calcium. The calcium content in raw finger millet was recorded as 337.31 mg/100g and the value for roasted finger millet was observed as 341.24 mg/100g as show in Figure 3. Calcium content of 36 genotypes of finger millet ranged from 162 to 487 mg/100g with mean value of 320.8 mg/100g (Vadivoo *et al*., 1998) [38]. The average calcium content (329 mg/100g) in white varieties was considerably higher than the brown (296 mg/100g) varieties (Seetharam, 2001). Bhatt *et al*. (2003) [5, 6] reported the calcium content of finger millet as 344 mg/100g.

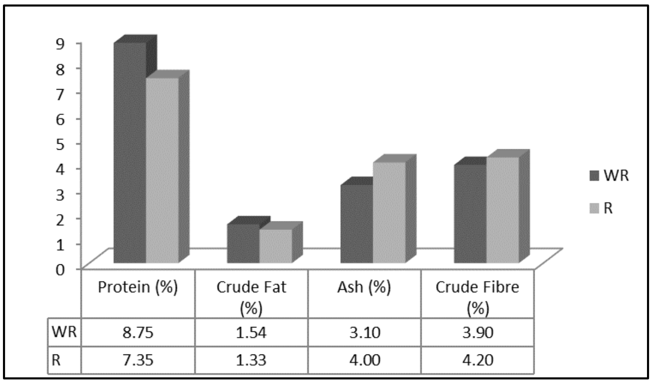

Fig 2: Protein, crude fat, ash, crude fibre and iron content of without roasted (WR) and roasted (R) finger millet.

3.10 Total Phenols
The total phenolic content in unroasted and roasted samples was observed as 314.24 and 223.31 mg/100g, respectively as shown in Figure 3. The reduced TPC in finger millet grains could be due to the degradation of phenolics upon heat treatment or leaching into the endosperm to form complexes with proteins and other macromolecules, thus making phenolics less extractable. Processing of finger millet like thermal or hydrothermal treatments, germination, decortication, or fermentation has been found to generally decrease the polyphenol levels resulting in a reduced radical quenching ability than that of the unprocessed grain (Towo *et al*., 2003; Shobana and Malleshi, 2007) [37, 12]. Towo *et al*. (2003) [37] reported that boiling finger millet and red sorghum for 15 min reduced their total extractable phenolics by 40 per cent and 80 per cent, respectively. Dewanto *et al*. (2002) [13] showed a significant increase of total free phenolics and antioxidant activity in sweetcorn following thermal treatment with increased heating times and temperatures.

3.11 Antioxidant activity (DPPH free radical scavenging activity)
Finger millet grains, particularly the seed coat, contain high amount of various phenolic compounds (mostly derivatives of benzoic acid) which have been reported to exhibit antioxidant activity (Hegde and Chandra, 2005; Chandrasekara and Shahidi, 2010) [16, 11]. The antioxidant activity in unroasted sample was recorded as 89.89 per cent which was seen to decrease to 86.78 per cent in roasted sample (Fig.3). Some researchers (Vogrincic *et al*., 2010; Zielinska *et al*., 2007) [39, 41] showed that thermal processing decreased the DPPH radical scavenging activity of buckwheat which could be due to the binding of phenolics to other molecules such as proteins or some of phenolics may not be readily extractable after the thermal processing.

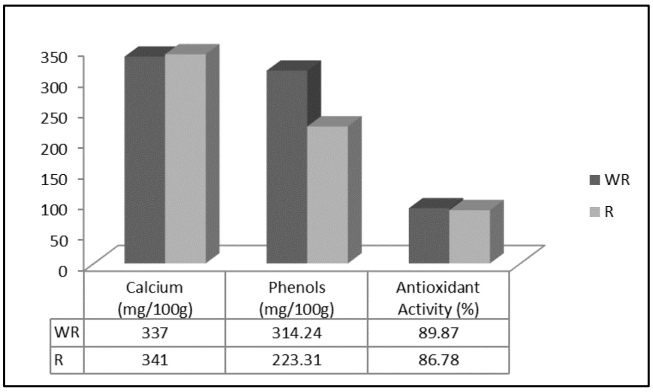

Fig 3: Calcium, total phenolic content and antioxidant activity of without roasted (WR) and roasted (R) finger millet.

4. Conclusion
Finger millet is an important staple food in parts of eastern and central Africa and India. It is non acid forming food and easy to digest. Roasting and grinding processes render the grain digestible. The chemical constituents such as moisture, fat and protein tends to decrease slightly whereas total carbohydrate content, ash, fibre increases along with the increase in the bio-availability of minerals like calcium and iron on roasting. Finger millet is source of antioxidants such as phenolic acids and glycated flavonoids. A decrease in phytochemical constituents like phenols and antioxidant activity was observed in roasted samples, which is probably

due to the heat induced changes in the phenolic compounds. The present results reveal that finger millet is a rich source of primary metabolites and has the potentiality to be utilized as a non-conventional food to supplement the nutritional requirements of the undernourished population. It is also characterized to be a potential prebiotic and can enhance the viability of probiotics with potential health benefits.

5. References

1. AOAC. Official methods of analysis, Association of Analytical chemists. Washington, D.C., 17th edition, 2000.
2. Antony U, Chandra TS. Antinutrient reduction and enhancement in protein, starch and mineral availability in fermented flour of finger millet (*Eleusine coracana*). J Agric Food Chem. 1998; 46(7):2578-2582.
3. Antony U, Sripriya G, Chandra TS. Effect of fermentation on the primary nutrients in finger millet (*Eleusine coracana*). J Agric Food Chem. 1996; 44:2616-2618.
4. Babu BV, Ramana T, Radhakrishna TM. Chemical composition and protein in hybrid varieties of finger millet. Indian J Agric Sci. 1987; 57(7):520-522.
5. Bhatt A, Singh V, Shrotria PK, Baskheti DC. Coarse Grains of Uttaranchal: Ensuring sustainable Food and Nutritional Security. Indian Farmer's Digest. 2003, 34-38.
6. Bhatt A, Singh V, Shrotria PK, Baskheti DC. Coarse Grains of Uttaranchal: Ensuring sustainable Food and Nutritional Security. Indian Farmer's Digest. 2003, 34-38.
7. Bookwalter GN, Lyle SA, Warner K. Millet processing for improved stability and nutritional quality without functionality changes. J Food Sci. 1987; 52(2):399-402.
8. Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. Lebenson Wiss Tech. 1995; 28:25-30.
9. Bray HG, Thorpe WV. Standard methods of biochemical analysis. Kalyani Publishers, New Delhi, India, 1954.
10. Camire ME. Extrusion cooking: Technologies and applications. CRC Press, Woodhead Publishing Co., Cambridge, England. 2001, 109-129.
11. Chandrasekara A, Shahidi F. The content of insoluble bound phenolics in millets and their contribution to antioxidant capacity. J Agric Food Chem. 2010; 58:6706-6714.
12. Chethan S, Malleshi NG. Finger millet polyphenols: optimization of extraction and the effect of pH on their stability. Food Chem. 2007; 105:862-870.
13. Dewanto V, Wu X, Liu RH. Processed sweet corn has higher antioxidant activity. J Agric Food Chem. 2002; 50:4959-4964.
14. Gahlawat P, Sehgal S. Protein and starch digestibility and iron availability in developed weaning foods as affected by roasting. J Hum. Nutr. Diet. 1994; 7(2):121-126.
15. Geervani P, Vimala V, Uma Pradeep K, Rama Devi M. Effect of processing on protein digestibility biological value, and net protein utilization of millet and legume based infant mixes and biscuits. Plant Foods Hum. Nutr. 1996; 49:221-227.
16. Hegde PS, Chandra TS. ESR spectroscopic study reveals higher free radical quenching potential in kodo millet (*Paspalum scrobiculatum*) compared to other millets. Food Chem. 2005; 92:177-182.
17. Huffman SL, Martin LH. First feedings: Optimal feeding of infant and toddlers. Nutr. Res. 1994; 14:127-159.
18. Jideani IA, Takeda Y, Hizururi S. Structure and physico-chemical properties of starches from acha (*Digitaria exilis*) iburu (D. iburua) and tomba (*Eleusine coracana*). Cereal Chem. 1995; 73(6):677-685.
19. Joshi HC, Katoch KK. Nutritive value of millets: A comparison with cereals and pseudo cereals. Himalayan Res. Dev. 1990; 9:26-28.
20. Kamath MV, Belavady B. Unavailable carbohydrates of commonly consumed Indian foods. J Sci Food Agric. 1980; 31:194-202.
21. Krantz ME, Panaari S, Colgate S. Sarbottan pitho. a home prepared waeaning food for Nepal. Hoviprep monograph series no. 1. UNICEF/ US agency for international development. International Food and Nutrition Programme. 1983, 59.
22. Lewis KD, Lorenz K, Tribelhorn R. Puffing quality of experimental varieties of proso millets (*Panicum miliaceum*). Cereal Chem. 1992; 69(4):359-365.
23. Mittal M. Development of finger millet and barnyard millet based convenience mixes for food products and their evaluation for nutritional quality, storage stability and acceptability. Thesis. Ph.D. G.B. Pant Univ. of Agric and Technol. Pantnagar, 2002, 260.
24. Nestares T, Urbano G, Lo´pez-Fr´as M, Barrionuevo M. Nutritional assessment of magnesium from raw and processed chickpea (*Cicer arietinum* L.) in growings rats. J Agric Food Chem. 1997; 45:3138-3142.
25. Nirmala M, Subba Rao MVST, Muralikrishna G. Carbohydrates and their degrading enzymes from native and malted finger millet (ragi, *Eleusine coracana* Indaf-15) Food Chem. 2000; 69:175-180.
26. Onwuka GI. Food Analysis and Instrumentation; Theory and Practice. Naphthalic prints, Surulere, Lagos, Nigeria, 2005, 219-230.
27. Pamela CC, Richard AH, Denise RF. Lippincotts illustrated Reviews Biochemistry. Edn 3, Lippincott Williams and Wilkins, Philadelphia, 2005, 335-388.
28. Ramachandra G, Virupaksha TK, Shadaksharaswamy M. Relation between tannin levels and *in vitro* protein digestibility in finger millet (*Eleusine coracana* Gaertn.). J. Agric. Food Chem. 1977; 25(5):1101-1104.
29. Ranganna S. Handbook of analysis and quality control for fruits and vegetable products. Edn 2. Tata McGraw Hill Publishing Company Limited, New Delhi, India, 2010.
30. Rao BSN, Prabhavati T. An *in vitro* method for predicting the bioavailability of iron from foods. Am J Clin Nutr. 1978; 31:169-175.
31. Sankaran A. A laboratory manual for analytical chemistry. Asia Publishing House, Madras, India, 1966.
32. Seetharam A. Annual Report 2000-01 All India Coordinated Small Millets Improvement Project, Bangalore, 2001, 1-28.
33. Shobana S, Malleshi NG. Preparation and functional properties of decorticated finger millet (*Eleusine coracana*). Journal of Food Engineering. 2002; 79:529-538.
34. Singh P, Srivastava S. Nutritional composition of sixteen new varieties of finger millet. J. Community Mobilization Sustainable Dev. 2006; 1(2):81-84.
35. Sridhar R, Lakshminarayana G. Content of total lipids and lipid classes and composition of fatty acids in small

millets: foxtail (*Setaria italica*), proso (*Panicum miliaceum*), and finger (*Eleusine coracana*). Cereal Chem. 1994; 71(4):355-358.
36. Srivastava PP, Das H, Prasad S. Effect of roasting process variables on hardness of Bengal gram, maize and soybean. J. Food Sci. Technol. 1994; 31(1):62-65.
37. Towo EE, Svanberg U, Ndossi GD. Effect of grain pre-treatment on different extractable phenolic groups in cereals and legumes commonly consumed in Tanzania. J Sci Food Agric. 2003; 83:980-986.
38. Vadivoo AS, Joseph R, Garesan NM. Genetic variability and calcium contents in finger millet (*Eleusine coracana* L. *Gaertn*) in relation to grain colour. Plant Foods Hum Nutr. 1998; 52(4):353-364.
39. Vogrincic M, Timoracka M, Melichacova S, Vollmannova A, Kreft I. Degradation of rutin and polyphenols during the preparation of tartary buckwheat bread. J Agric Food Chem. 2010; 58:4883-4887.
40. Wankhede DB, Shehnaj A, Raghavendra Rao MR. Carbohydrates composition of finger millet (*Setaria italica*). Plant Foods Hum Nut. 1979; 28:293-303.
41. Zielinska D, Szawara-Nowak D, Zielinski H. Comparison of spectrophotometric and electrochemical methods for the evaluation of the antioxidant capacity of buckwheat products after hydrothermal treatment. J Agric Food Chem. 2007; 55:6124-6131.