INTERNATIONAL JOURNAL OF ADVANCES IN PHARMACY, BIOLOGY AND CHEMISTRY

Research Article

Preliminary Phytochemical, Nutritional Potential of cereal Grass Powder Based Products for Effective Management of Diabetes

N. Chaturvedi* P. Sharma and S. Rohtagi

Department of Food Science and Nutrition, BanasthaliUniversity, Rajasthan, India.

ABSTRACT

Cereal grasses such as wheat, oat,rye, barley and brown rice are most familiar cereal grasses are one of the "functional foods" that is gaining recognition as a potential nutritional product which has medical and health benefits. They are excellent source of vitamin, minerals, antioxidant, amino acids, protein, chlorophyll and active enzymes. The study was conducted on preliminary phytochemical analysis, nutrientpotentialand to examine the glycemic response of T. dicoccum (Emmer wheat) and F. esculentum (Buckwheat) grass incorporated recipe in both non diabetic and diabetic subjects. The Preliminary phytochemical study showed the presence of tannins, terpenoids and flavonoids in diccocum wheat grass whereas the buckwheat grass has tannins, flavonoids, steroids and saponins. The T. dicoccum grass powders was rich source of protein,crude fiber, calcium and iron i.e. 21.0±1.09 g/100g, 22.6±0.91g/100g, 240±0.88mg/100g and 0.88±0.98mg /100g respectively. The F. esculentum also has good amount of crude fiber and protein i.e. 19.9±0.59 and14.08±0.89g/100g respectively as compared to T.aestivum (Common wheat).The incorporated products with 20% and 30% grass powders were comparable with standard product. Further study was conducted on randomly selected normal healthywere fed two test recipes (Momos and Bati) to observe its glycemic response. It was found that the Glycemic Index elicitedby dicoccum and esculentumbased Momo was44.16 and 49.74 where asBati showed 46.45 and 48.76 respectively. Thus, both the grasses have a definite role in lowering the glycemic response and could be effectively used in the management of diabetes mellitus.

Keywords: T.diccocum, F.esculentum,Phytochemicals,Glycemicresponse,Diabetes.

INTRODUCTION

Diabetes mellitus is a worldwide disease found in all nations of the world. There has been an explosive increase in the diabetics in the last two to three decades. Diabetes has become a major health concern global with over 190 million suffering from disease now with a prospective to have 324 million by 2025. Type 2 constitutes 90 % of the total diabetics in most countries with nearly 80% of the burden in developing countries (*Sicree et al, 2006*). Particularly in India, there are currently 50 million people with diabetes, which is projected to increase by 90 million in the 2030(*Garg and Garg, 2008*). The fear of diabetic epidemic booms with statements in the press that read as "every fifth Indian and every fifth diabetic will be an Indian". The fact confirmed by reports from the World Health Organization (WHO) shows that India has the largest number of diabetic subjects in the world (*Kim et al, 2006*).Managing diabetes, a lifelong ailment, with medicines is very expensive and diet plays a crucial role in reducing the levels of plasma cholesterol and lowering glycemic response (*Yenagi et al, 2001*).The diet plays a significant role, especially the concept of low glycemic index foods in their diet helps in preventing associated metabolic disorder Diabetes Mellitus and Cardiovascular Disease (*Mani et al, 1992*).In this regard cereal grasses are the young green plant that grows to produce the cereal grains in an upcoming "functional foods". This may be of importance because of its nutritional and health benefits. A functional food is defined as "any food that has a positive impact on an individual health, physical performance or state of mind in addition to its nutritive value"(*Saikia andDeka 2011*)

India is the second largest producer of wheat in the world with five out of eighteen known wheat species under cultivaton and three species of wheat namely, *T.aestivum*(bread wheat), *T.durum* (macroni wheat) and *T.dicoccum*(Emmer or khapli) grown on commercial basis in the Indian subcontinent from prehistoric times (*Superkar et al, 2005*). *The dicoccum*or emmerwheat is one of the most important older wheat species and, together with barley, was the earliest domesticated cereal growninthe MiddleEast, Central and West Asia and Europe. It has been largely replaced by hulless species and is now a minor crop in some countries like India, Ethiopia and Yemen, where it is used for traditional foods (*Zaharieva et al, 2010*).

Dicoccum wheat varieties are proved to be nutritionally and therapeutically superior in protein and dietary fiber, low in carbohydrate digestibility and glycemic value, which are vital factors in the management of metabolic disorders, viz., diabetes mellitusand heart diseases.The*dicoccum* wheat is particularly appreciated for its content of dietary fiber, protein, resistance starch, and has been considered as a mild but effective regulator of intestinal function. Likewise*dicoccum*, Buckwheat(*Fagopyrumesculentum*Moench), family *Polygonaceae*,classified as a pseudocereal, is one of the traditional cropcultivated in central and eastern Europe and Asia, and it is now a part of the renewed interest in alternative crops for organic cultivation and healthy foods (*Kreft*,*et al* 1998). Traditionally, milled buckwheat can be used for pasta, blended bread, and other types of flour products. . As it has no gluten, buckwheat is safe for patients with celiac disease, providing them an adequate intake of nutrients (*Alvarez-Jubeteet al* 2010). Buckwheat protein consists of well-balanced amino acids with high biological value compared with other cereal proteins (*Pomeranz.*1983*)*. Buckwheat is also known as an abundant source of dietary minerals like zinc, copper, and manganese (*Ikeda and Yamashita. 1994*).One positive characteristic of buckwheat concerns the prevention and treatment of both hypercholesterolemia and hyperglycaemia.The preventive effect may be connected with the content of dietary fiber in buckwheat (*Zhang, et al 2007*).

The purpose of this study was to explore the two cereal grasses viz.; *T.dicoccum and F. esculentum*respectively which have tremendous nutritional quality. The grasses have also phytochemicals plays a vital role in preventing body from various infections. The studied natural herbs have determined to have potential in getting body rid from invading diseases. In the lamp light of this study it has been tried to explore nutritional potential and to assess the suitability of cereal grass based products for the effective management of diabetes.

MATERIALS AND METHODS

The study was done on the cereal grasses to popularize their usage as medicinal herbs for people. Basically the herbs are useful for patients with obesity, diabetes as metabolic disorder. The research was carried out in five phases, commencing with the cultivation of selected cereal grasses viz; ***Triticumdicoccum**and* ***Fagopyrumesculentum*** followed by preliminary estimation of phytochemicals and chlorophyll estimation of grass powder. And then assessing the nutrient potential of the cereal grass powder and developing product based on its powder and assessing the suitability of most acceptable products for effective management of diabetes.The fresh cereal grasses (*Triticumaestivum, Triticumdicoccum and Fagopyrumesculentum*) were cultivated in nursery of KrishiVigyan Kendra , Banasthali University. Phytochemicals and nutrients analysis were completed in laboratory of Biochemistry, Department of Food Science and Nutrition, BanasthaliUniversity.The present work was divided into 5 phases.

Phase I

Cultivation and processing of cereal grasses was done. Firstly, cereal grasses were cultivated and then the green cereal grasses were dried and powdered.

PhaseII

Preliminary estimation of Phytochemicals;flavonoids,glycosides,saponins,terpenoids and tannins were done and followed by Chlorophyll estimation with standard methods(Handa 1995).

Phase III

Analysis of the proximate composition of cereal grass powder comprising of moisture, ash, crude fibre, protein, fat and minerals like calcium and iron were estimated by standard method.(AOAC, 1984).

Phase IV

Product development was prepared by using cereal grass powder as an ingredient in different concentrations. Further sensory evaluation was completed by using 9 point hedonic scale and the sensory attributes covered were appearance, color, texture, taste, flavor and overall acceptability.

Phase V This phase comprised of the analysis of Glycemic Index of most acceptable products on the healthy subjects. Lastly, statistical analysis using mean, standard deviation and Studentt- test.

RESULTS AND DISCUSSION

Commencing with the cultivation of cereal grasses , preliminary phytochemicals and chlorophyll estimation and then determining the proximate nutrient composition (moisture, ash, protein, crude fiber, fat etc.). Further, the study include product development from both the grass powders and assessing their acceptability through 9- point hedonic scale and selecting the most acceptable product to be given to subjects to find their glycemic index for management of diabetes. About 1 kg *T.dicocum* grass powder was obtained from 10-12 kg of fresh wheat grass and 1.2kg of *F.esculentum*powder was obtained from 10-12 kg of fresh buckwheat grass.

Preliminary phytochemical analysis of *T.dicoccum* grass powder(Table1) showed the presence of tannins, flavonoids and terpenoids and *F.esculentum*(Buckwheat) powder showed tannins, steroids and saponins. Though Buckwheat herb is rich in flavonoids, which have been identified as potent antioxidant (*Hinneburg and Neubrett, 2005*), and also known for their effectiveness in reducing blood cholesterol, keeping capillaries and arteries strong and flexible, and assisting in prevention of high blood pressure (*Izydorczyk, 2003*). Study done on phytochemical quantification and total antioxidant capacities of emmer and einkorn wheat showed that emmer wheat has high content of flavonoid suggesting that they may have high potential for utilization as a novel grain, rich in natural antioxidant (*Serpen et al, 2008*).

The amount of chlorophyll of *T.dicoccum* and *F.esculentum* was 1160mg/100g and 416mg/100g respectively. Chlorophyll is a substance that is found exclusively in plants. The grasses are regarded as healer, blood regenerator also helpful in reverse metagenic activity (W*igmore,1985*).The purification feature of chlorophyll, stops the growth of bacteria in wounds, eliminates odors of the body, bad breath, and removes chemicals from your body through detoxification (*Premakumari*and*Haripriya, 2010*).

The table 2 shows analysis of proximate composition , the moisture content of *T.dicoccum* and *F.esculentum* grass powder come out to be 11.5±0.71g/100g and 5.92±0.61g/100 respectively shows that the *esculentum*grass powder was significantly decrease at $p \leq 0.05$level when compared with *aestivum*grass powder with moisture content 12.2±0.58g/100g.. Crude fiber of *aestivum* was 17.2±1.02 g/100g and dicoccum *and**esculentum*grass powder was22.6±0.91g/100g and 19.9±0.59g/100g respectively. Both the grasses showed significant increase at $0.01 \geq p \leq 0.05$level in crude fibrecontent .This can be predicted that both the grasses have good amount of crude fiber which can be good in preventing body from various metabolic disorders (*Meycrowitz* and *Steve, 1999*).The protein content of the *dicoccum* wheatgrass is higher than the *aestivum grass* (*Reddy et al, 1998*). Thestudy interpreted that there wasno significant increase in the protein content (21.0± 1.09g/100g) of the *dicoccum*grass powder when compared with the *T.aestivum (20.02± 0.17g/100g),* but buckwheat content was significantly decreased(14.08±0.89 g/100g). Physiological investigation by*Edwardson, 1996,* on wheat genotypes showed that the protein content in the wheatgrass 20.5g/100 g and *buckwheat* was12.3g/100g**.** *Buckwheat* is one of the best sources of high quality, easily digestible protein in the plant kingdom.The human bodycan utilize 74% of the available protein in *buckwheat* (*Izydorczyk, 2003*). The fat content in *dicoccum* and *buckwheat* grass powder was 0.2±0.78g/100g and 0.9±51g/100 g respectively. *Dicoccum*showed no significant difference from the standard *aestivum* grass i.e. 0.2±0.31g/100g whereas *buckwheat* showed increased in fat content(0.9±0.51).However, it has been studied that both the grasses does not contain fat (*Edwardson, 1996).* The studyalso depictedthat vitamin C of*dicoccum* (0.4 ±0.73mg/100g) and(0.3± 0.92mg/100g) grass powder was significantly decreased dueto sun drying. . Through the investigation it has been found that fresh wheatgrass is an excellent source of Vitamin C, E, beta carotene and vitamin B (*Premakumari and Haripriya, 2010*). The Calcium contentwas found to be 240±0.88mg/100g (*dicoccum*) and 85.64±0.31mg/100g (*esculentum*)grass powder respectively. Content of Calcium for *buckwheat* grass powder had significant difference at $0.01 \geq p \leq 0.05$ levels when compared with *aestivum* grass powder (242±0.63mg/100g). It was estimatedthat ironcontent was 0.88±0.98mg/100g in dicoccum wheat grasswhereas in*esculentum* powderwas found to be 0.21±0.56mg/100g respectively. It was found to be no significantly different from the standard grassi.e. *aestivum, 0.52*±0.58mg/100g *at*$0.01 \geq p \leq 0.05$ levels.

Four recipes Momo,Bati,Laddoand Manchurian were developed with three variation in each recipeby incorporating the grass powder in concentration of 20%, 30% and 40% assigned as A, B and C, and D respectively and compared with standard recipe(S).Table 3 and Figure 1 depicts the overall acceptability comparison between the standard and the two grasses *dicoccum*and *esculentum*powder based products. There was no significant difference found in between the Standard(S) and Group A(20% concentration) of all products(Momos, Bati, Manchurian and Laddo) of both the grasses. Also all the products in the Group B (with 30% concentration) except the Laddo incorporated with *esculentum*grass powder found to be significantly different at $0.01 \geq p \leq 0.05$ level. This may be due to the texture and bitter after taste of the product. Momos and Bati from Group A were most acceptable by the panels and had no significant difference so they were used for the intervention for effective management of diabetes. Further, the study was conducted on 18 normal subjects (24-30 y) .The Mean±SD weight and height of the normal subjects was (55.36±4.72) kg and (157.62±4.14) cm respectively. The mean body mass index (BMI) of the subjects was (22.30±1.98)kg/m^2. Multitude of empirical investigations has proved that different carbohydrates exert different effects of glucose absorption and metabolism. Absorption pattern of carbohydrate is reflected by difference in glycemic response. Glycemic index (G.I.) of a food is considered a useful indicator for its suitability in diabetic diet and is helpful in lowering the fat and increasing the fiber content of the diet. (*Frost et al, 1994).*Figure3 and4shows that the peaks raise in blood glucose occurred after 60 min of eating, indicting slower digestion and absorption of carbohydrate from food products. After 60 min blood glucose values started declining and reached to base line value after two hours. Table 5 reveals that the area under the curve (AUC) for glucose ranged from 333.75 to 337.92 mg.min/100ml whereas AUC values for test food product Momo ranged from 149.23 (*dicoccum* grass powder based) to 166.01 (*esculentum* grass powder based) whereas Bati ranged from 155.4-164.1mg.min/100ml. The glycemic indexof food products based on *dicoccum and esculentum* grass powders were 44.16 and 46.45 for momos whereas 49.74 and 48.76 for Bati respectively. Both test products come under low G.I.foods. The following cut-off limits between low, middle and high GI have been proposed: <55 % (low), 55-70 % (medium), > 70 % (high) (*Monro, 2002*).The present study demonstrated that low glycemic index, nutritious and acceptable food products prepared from cereal grasses viz.,*T. dicoccum* and *F. esculentum* can be used as effective supportive therapy in the treatment of diabetes mellitus.

CONCLUSION

As indicated by the results, the developed products showed a low GI which can be included in the diet for the management of diabetes more effectively low glycemic index food reduce the insulin demand and have ability to prolonged absorptive phase of food which will favor a more efficient suppression of free fatty acid thus improving insulin sensitivity at the time of next meal which may leads to improvement in glucose and lipid metabolism in diabetes. Thus,the grasses are rejuvenators and energize the body depicting their therapeutic property. The products designed from the grasses were nutritious and showed impressive potential as health beneficiers.

Table 1: Preliminary Phytochemicals Analysis of Cereal Grass Powder

Phytochemicals	*Triticumdicoccum* (Wheat)	*Fagopyrumesculentum* (Buckwheat)
Tannins	+ ve	+ ve
Glycosides	-ve	-ve
Flavonoids	+ve	+ve
Steroids	-ve	+ ve
Saponins	-ve	+ ve
Terpenoids	+ ve	-ve

Table 2: Proximate Nutrient Composition of *T. dicoccum*and *F.esculentum*Grass Powderon Dry Basis

Proximate Composition	*T.aestivum* grass	*T.dicoccum* grass	*F.esculentum* grass
Moisture (g/100g)	12.2±0.58	11.5±0.71^{a}	5.92±0.61^{ab}
Ash (g/100g)	5.5±0.82	6.08±0.88	3.53±0.71^{ab}
Crude Fibre(g/100g)	17.2±1.02	22.6±0.91^{ab}	19.9±0.59^{ab}
Protein (g/100g)	20.02±0.17	21±1.09	14 .08±0.89^{ab}
Fat (g/100g)	0.2±0.31	0.2±0.78	0.9±51^{ab}
Vitamin C(mg/100g)	1.3±0.61	0.4±0.73^{ab}	0.3±0.92^{ab}
Calcium (mg/100g)	242±0.63	240±0.88	85.64±0.31^{ab}
Iron (mg/100g)	0.52±0.58	0.88±0.98^{ab}	0.21±0.56^{ab}

Values: Mean ± SD (Triplicate readings)
a is significant at p≤0.05 level and b is significant at p ≤ 0.01 level
When compared with data of *T.aesivum* (standard) grass powder

Table 3: Sensory Evaluation (Overall acceptability) of the products developed from grass powder

Food Product		Standard	Group A	Group B	Group C
bbbbb	*T. dicoccum*	8.7±0.34	8.5±0.32	7.9±0.42	6.3±0.97[a]
	F.esculentum		8.5±0.12	8.0±0.89	6.5±0.97[ab]
Bati	*T. dicoccum*	8.6±0.34	8.3± 3.6	7.9±0.20	6.5±0.2[a]
	F.esculentum		8.4±0.23	7.9±0.42	6.3±0.92[a]
Manchurian	*T. dicoccum*	8.8±0.14	8.3±0.45	8.1±0.17	6.7±0.35[ab]
	F.esculentum		8.3±0.45	7.9±0.37	6.8±0.75[ab]
Laddo	*T. dicoccum*	8.6±0.34	8.5±0.02	8.2±0.42	6.3±1.07[a]
	F.esculentum		8.4±0.32	7.3±0.42[ab]	6.5±1.17[ab]

Values: Mean ± SD (Triplicate readings)
a is significant at $p \leq 0.05$ level and b is significant at $p \leq 0.01$ level
S: Standard recipeA: 20%, B: 30% and
C: 40% incorporation with *T.dicoccum* and *F.esculentum*grass powder

Table 4: Area under Glucose Response Curve (AUC)* and Glycemic Indices (GI)* ForFood Products

	*T.dicoccum*Grass Powder			*F.esculentum*Grass Powder		
Food Product	AUC for food product, mg.min/100 ml	AUC for glucose, Z mg.min/100ml	G.I.	AUC for food product, mg. min/100ml	AUC for glucose, mg.min/100ml	G.I.
Momo's	149.23	337.92	**44.16**	166.01	333.75	**49.74**
S.D. ±	35.25	100.96		55.32	101.01	
Bati	155.43	334.56	**46.45**	164.16	336.64	**48.76**
S.D. ±	75.93	98.89		59.39	100.34	

Value: Mean± SD of 6 subjects* significant at $p \leq 0.05$ and**significant at $p \leq 0.01$Z

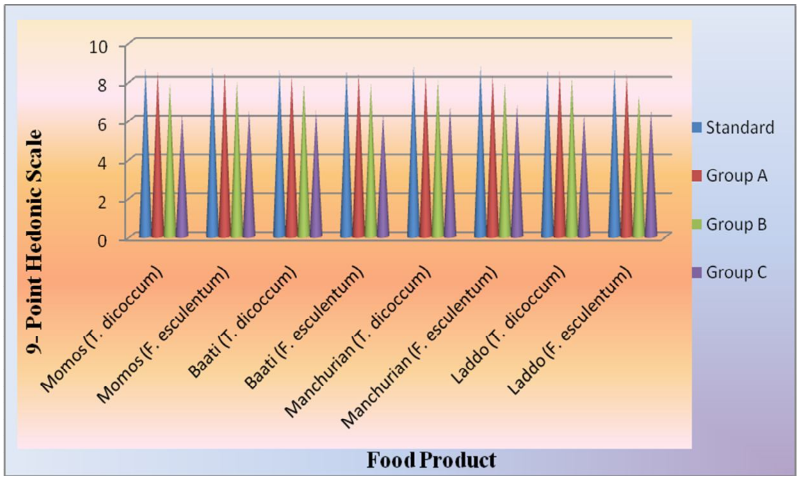

Fig. 1: Sensory Evaluation (overall acceptability) of the products made from grass powder

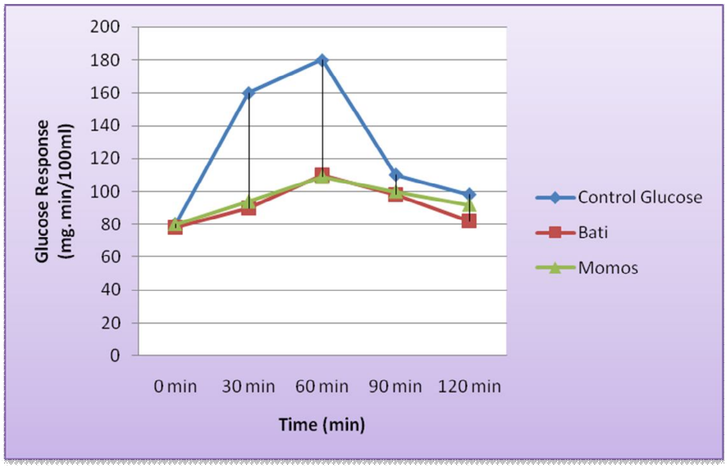

Fig. 2 Blood Glucose response curve of *T. dococcum* grass powder based product on normal subjects

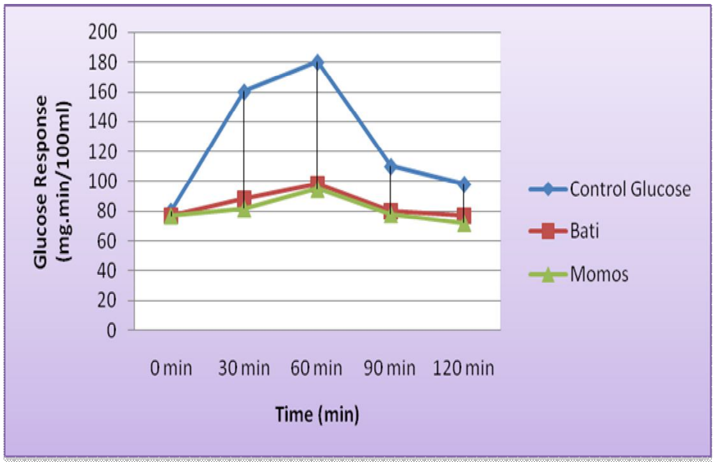

Fig. 3: Blood Glucose response curve of *F. Esculentum* grass powder based products on normal subjects

REFERENCES

1. Alvarez-Jubete N, Arendt EK and Gallagher E. Nutritive value of pseudocereals and theirincreasing use as functional gluten-free ingredients. Trends Food Sci Technol. 2010;21(2): 106-113.
2. AOAC, Official Method of Analysis, Association of Official Analytical Chemists, 1984, Washington DC.
3. Edwardson S, Buckwheat: Pseudocereal and Nutraceutical. In J Janick (ed), Progress in new crop. ASHS Press. Alexandria,VA, 1996; 195-207.
4. Frost G, Willding JPH, Beechem J, Dietary advice based on the glycemic index improves dietary profile and metabolic control in glycemic index improves dietary profile and metabolic control in type 2 diabetic patients. Diabetic Med., 1989; 11:397-401.
5. Garg M, Garg C, Scientific alternative approach in Diabetes-As overview. Pharmacognosy Reviews, 2008; 2(4):284-301.
6. Handa SS, Quality control and standardization of herbal material and traditional remedies. East pharma., 1995; 38:23-25.
7. Haripriya S, Premakumari S, Effect of wheat bran on diabetic subjects,Indian J.Sci.Technol., 2010; 3: 284-286.
8. Hinneburg I, Neubret RH, Influence of extraction parameters on the phytochemical characteristics of extracts from buckwheat (Fagopyrumesculentum)

herb. J Agri. Food Chem., 2005; 12(1): 3-7.

9. Ikeda S, Yamashita Y, Buckwheat as a dietary source of zinc, copper and manganese,Fagopyrum.1994; 14:29-34.
10. Izydorczyk M.S, Jacobs M, Dexter JE, Distribution and structural variation of non starch polysaccharides in milling fractions of hull-less barley with variable amylase content, Cereal Chem.., 2003; 80:645–653.
11. Kim JH, Stewart TP, Soltani-Bejnood M, Wang L, Fortuna JM, Mostafa OA, Moustaid-Moussa N, Shoieb AM, McEntee MF, Wang Y, Bechtel L, Naggert JK, Phenotypic characterization of polygenic type 2 diabetes in TALLYHO/Jng J mice, JEndocrinol.,2006; 191:437-46.
12. KreftI, Skrabanja U, Ikeda k, Bonafaccioa G, Buckwheat Nutritional value and Technological Properties. J. Agric. Food Chem., 1998; 47: 4649-4652.
13. Mani UV, Pradhan SN, Mehta NC,Thakur DM, Iyer U, Mani I,Glycemic index of conventional carbohydrates meals. Br. J. Nutr., 1992; 68:445-450.
14. Meyerowitz, Steve,Wheat grass nature’s finest medicine. Mass US: sproutman, 1999; 58:98-106.
15. Monro JA, Glycaemic glucose equivalent: combining carbohydrate content, quantity and glycaemic index of foods for precision in glycaemia management.Asia Pacific. J Clin.Nutr., 2002; 11(3): 217–225.
16. Pomeranz Y, Buckwheat: structure, composition, and utilization, CRC Crit. Rev. Food Sci. Technol., 1983; 19: 213–258.
17. Reddy MM, Yenagi NB, Rao M, Srinivasan CN, Hanchinal RR,Grain and gluten quality of some cultivators of wheat species and their suitability for preparation of traditional south Indian sweet products, J. Food Sci. Tech., 1998; 35(5):441-444.
18. Saikia, DandDekaSC , Cereals: from staple food to nutraceuticals.Intl. F. Res. J., 2011; 18: 21- 30.
19. Serpen A, Gökmen V, Karagöz A, Phytochemical quantification and total antioxidant capacities of emmer (TriticumdicocconSchrank) and einkorn (Triticummonococcum L.) wheat landraces, J Agric. Food Chem., 2008; 56(16):7285-7292.
20. Sicree R, Shaw J, Zimmet P, Prevalence and projections In:D. Gan ed. Diabets Atlas, World Diabetes Foundation. Brussels, Belgium:Int. Diabetes Federation, 2006; 3:16-104.
21. Superkr DT, Patil SR, Munjal SV, Comparative study of some important aestivum,durum and dicoccum wheat cultivaras for grain,flour quality and sutability for chapatti making characterstics, J. Food Sci. tech., 2005;42(6):488-492)
22. Wigmore A, The wheatgrass book. 1985; Avery Publishing Group Inc., Wayne, New Jersey, p.129.
23. Yenagi NB, Hanchinal RR, Patil CS,Koppikar V,Glycemic andlipidemic response to dicoccum wheat (Triticumdicoccum) in the diet ofdiabetic patients,Int J Diab. Dev.Ctries. 2001;21:153-5
24. Zaharieva M, Ayana NG, Al Hakimi A, Misra SC, Monneveux P, Cultivated emmer wheat (TriticumdiccocumSchrank), an old crop with a promising future: a review, Genetics Resources and Crop Evolution.,2010;57: 937–962.
25. Zhang HW, Zhang YH, Lu MJ, Tong WJ, Cao GW, Comparison of hypertension,dyslipidaemia and hyperglycaemia between buckwheat seed-consuming and non-consumingMongolian-Chinese populations in Inner Mongolia, China, Clin. Exp. Pharmacol. Physiol., 2007; 34 (9): 838-44.