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Proximate Composition, *In vitro* Digestibility and Anti Nutritional Factors of Millets and Legume Grains

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ABSTRACT

Background: Whole grains serve as a preferred carbohydrate source in a modern Indian diet to achieve a balance of macronutrients, micronutrients, fibers and phytochemicals for optimal health promotion and prevent chronic diseases such as type 2 diabetes, cardiovascular disease (CVD) and obesity. The five most common ancient grains that have the potential to be used more in Indian cooking are amaranth, barley, pearl millet, finger millet and sorghum. These grains have higher fiber and protein content.

Methods: The study was conducted to investigate chemical composition, sugar content, *in vitro* protein and starch digestibility and antinutrient content of pearl millet, sorghum and mung bean. Effect of blanching and germination on chemical composition of pearl millet and mung bean, respectively were determined.

Conclusion: The results of proximate composition of grains revealed that germinated mung bean had significantly highest amount of protein, total soluble sugar, non reducing sugar content, *in vitro* protein digestibility. Sorghum had significantly higher content of total carbohydrate, reducing sugar, starch and *in vitro* starch digestibility. Crude fat, phytic acid and polyphenol were highest in unprocessed pearl millet. Germination and blanching of seeds cause the significant reduction in anti-nutrient content of mung bean and pearl millet, respectively.

Key words: Anti-nutritional factors, *In vitro* digestibility, Proximate composition, Sugars.

INTRODUCTION

India is the largest producer of many kinds of coarse cereals/ millets which includes pearl millet, sorghum, oat, finger millet, foxtail millet *etc*. Among these, pearl millet and sorghum are unique millets which are rich in dietary fiber, micronutrients and phytochemicals. Research shows that sorghum and pearl millet grains are nutritionally comparable or even superior to major cereals such as wheat and rice owing to higher levels of protein with more balanced amino acid profile, dietary energy, vitamins, several minerals (especially micronutrients such as iron and zinc), insoluble dietary fiber leading to lower glycemic index. In addition to their nutritive value, several potential health beneûts such as preventing cancer and cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, cholesterol and rate of fat absorption, delaying gastric emptying, and supplying gastrointestinal bulk have been reported for millet (Gupta *et al.* 2012; Patni and Agrawal 2017).

Legumes have been considered as a cheap source of protein to the people. They contain 2 to 3 times more protein than cereals. They have shown numerous health benefits due to their dietary fibre content such as lower glycemic index for people with diabetes increased satiation and cancer prevention as well as protection against cardiovascular diseases (Polak *et al.* 2015; Cakir *et al.* 2019). Mung bean (*Vigna radiata*), also called green gram is a tropical legume, widely grown in Asia, particularly in Thailand, India and Pakistan. Mung bean is 3rd most important crop of India, in terms of cultivated area and production, accounting for 9 per cent of total legumes production. Mung bean is rich source of protein and amino acid especially lysine and thus can supplement cereal based human diets. It is good source of thiamin, niacin, vitamin B_6, pantothenic acid, iron, calcium, magnesium, phosphorus and potassium and very good source of dietary fiber, vitamin C, vitamin K, riboflavin, folate, copper and manganese (Dahiya *et al.* 2015; Yi-Shen *et al.* 2018).

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MATERIALS AND METHODS

Source of raw material

The samples of pearl millet (*Pennisetumglaucum*) (WH-901-445) were procured from Bajra section, sorghum [*Sorghum bicolor* (L.) Moench] (HC-125) from Forage section, mung bean (*Vigna radiata*) (MH-125) from Pulses section, Department of Genetics and Plant Breeding, College of Agriculture, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The seeds were cleaned and made free of dust, dirt and foreign materials prior to processing and product development. Raw materials were stored in clean and hygienic condition for further use.

Preparation of sample

Blanching of pearl millet

Blanching of pearl millet was done by the process of Chavan and Kachare (1994). Distilled water was brought to boiling to 98°C in an aluminium container. The grains were subjected to boiling water (1:5 ratio of seeds to boiling water) for 30 seconds and dried at 50°C for 60 minutes.

Germination of mung bean

Mung bean grains were first cleaned and free from broken seeds, dust and other foreign materials and then soaked in tap water for 12 h at 37°C. Seed to water ratio of 1:5 (W/V) was used. The unimbibed water was discarded. The soaked seeds were germinated in sterile petri dishes lined with wet filter paper for 48 h at 37°C with frequent watering. The sprouts were rinsed in distilled water and dried at 50-55°C.

Unprocessed sample of pearl millet, sorghum, mung bean, blanched pearl millet and germinated mung bean were ground to fine powder.The resultant flours were packed in air tight plastic containers.

Nutritional evaluation of raw and processed sample of pearl millet, sorghum and mung bean

Proximate composition of sample was determined according to AOAC (2000) method. Total carbohydrate was calculated by difference method. Total soluble sugars were estimated by using the method of Yemm and Willis (1954). Reducing sugars were estimated by using Somogyi's modified method (Somogyi, 1945). The amount of non-reducing sugar was calculated as the difference between total soluble sugars and reducing sugars. Starch from the sugar free pellet was estimated by using the method of Clegg (1956). *In vitro* protein digestibility was carried out by the modified method of Mertz *et al.* (1983). The nitrogen contents of the sample and the undigested residue were determined by the micro-kjeldhal method of AOAC, 2000. *In vitro* starch digestibility was assessed by employing pancreatic amylase (Singh *et al.*, 1982). Total polyphenols were extracted by the method of Singh and Jambunathan (1981). The amount of polyphenolic compounds was estimated as tannic acid equivalent according to Folin-Danis procedure (Swain and Hills, 1959).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using the SPSS Statistical Package.

RESULTS AND DISCUSSION

The data in respect to proximate composition of grains are presented in Table 1. Significant differences were observed in proximate composition of different grains analyzed in the present study. Moisture content of the different grains was in range of 9.48 - 10.96 per cent. As legumes are rich source of protein, significantly higher amount of crude protein was present in germinated mung bean (25.78%) and crude fiber in unprocessed mung bean (4.52%), respectively. These results are in agreement with the values reported earlier by various workers (Paul *et al.*, 2011; Dahiya, *et al.* 2015: Fayyaz, *et al.,* 2018). A non significant difference was observed for crude protein in soaked, dehulled and germinated mung bean by Tarun (2014). Pearl millet had the highest amount of crude fat (5.56%) as reported by Patni and Agrawal (2017). Among the different grains, sorghum had significantly higher content of total carbohydrates. These results are similar to that reported by Noha *et al.* (2011) and Ogbonna *et al.* (2012).

Sugars

Data in respect of total soluble sugar, reducing sugar and non-reducing sugar content of grains are presented in (Table 2).

Table 1: Proximate composition of grains (%, dry weight basis).

Grains	Moisture*	Crude protein	Crude fat	Crude fibre	Ash	Total carbohydrates
Pearl millet	10.80±0.03	11.92±0.03	5.56±0.23	1.49±0.03	2.39±0.03	78.62±0.23
Blanched pearl millet	10.96±0.03	11.55±0.03	5.34±0.10	1.54±0.03	2.45±0.03	79.09±0.10
Sorghum	9.98±0.01	10.16±0.01	1.73±0.14	1.69±0.03	1.80±0.1	84.60±0.15
Mung bean	9.48±0.09	24.88±0.01	2.83±0.06	4.52±0.03	3.89±0.03	63.88±0.05
Germinate mung bean	9.71±0.09	25.78±0.01	2.68±0.03	3.98±0.06	3.76±0.03	63.78±0.1
CD (P<0.05)	0.18	0.07	0.38	0.01	0.43	0.53

Values are mean±SE of three independent determinations.

*Moisture content on fresh weight basis.

Table 2: Sugar and starch content of grains (g/100 g, dry weight basis).

Grains	Total soluble sugars	Reducing sugars	Non-reducing sugars	Starch
Pearl millet	2.73±0.03	0.55±0.09	2.24±0.02	63.40±0.06
Blanched pearl millet	2.68±0.03	0.47±0.06	2.26±0.03	63.58±0.09
Sorghum	4.29±0.06	1.49±0.03	2.77±0.09	64.02±0.01
Mung bean	8.23±0.01	0.40±0.03	7.81±0.09	46.05±0.06
Germinate mung bean	10.23±0.01	0.64±0.06	10.00±0.01	37.93±0.02
CD (P<0.05)	0.03	0.37	0.03	0.04

Values are mean±SE of three independent determinations.

Among the grains, germinated mung bean had significantly higher content of total soluble and non-reducing sugars. These results are in agreement with those reported by earlier workers in legume (Kakati *et al*., 2010; Tarun, 2014). Germination (24h) also caused significant increase in sugar contents. The increase in sugars contents might be due to enzymatic hydrolysis of starch in to simple sugars. Hydrolysis of starch to monosaccharide, results in increased concentration of sugars in pulses. Observations of Kakati *et al.* (2010) that germination caused significant increase in sugar content in green gram and black gram. Sorghum exhibited significantly highest amount of reducing sugar and starch content. These results are in agreement with the earlier results reported by Elkonin *et al*. (2013) and Souilah *et al*. (2014).

In vitro digestibility

Data in respect of *In vitro* protein and starch digestibility of grains are presented in Table 3. Maximum *In vitro* protein digestibility (87.22%) was observed in germinated mung bean and sorghum (70.02%) and *In vitro* starch digestibility (32.96 mg maltose released/g) was highest in sorghum. Similar results were also reported in sorghum by Badubi (2012) and Elkonin *et al*. (2013). Similarly, Uppal and Bains (2012) found that *In vitro* protein digestibility in mung bean was highest after germination (89.1%). Other workers also reported improvement in protein digestibility after gemination (Olu *et al.,* 2013). The hydrolysis of seed proteins, protease inhibitors, phytic acid and polyphenols during germination may account for considerably increase protein digestibility in legumes (Chitra *et al.,* 1997).

Anti-nutritional factors

The data regarding phytic acid and polyphenol of grains are presented in Table 4. Anti-nutritional factors are compounds found in most food substances which are poisonous to humans or in some ways limit the nutrient availability to the body thus preventing optimal exploitation of the nutrients present in food and decreasing its nutritive value. For example phytic acid, lectins, tannins, saponins, amylase inhibitors and protease inhibitors have been shown to reduce the availability of nutrients and cause growth inhibition. Most of the toxic and anti-nutrient effects of these compounds in plant foods can be removed by several processing methods such as soaking, germination, boiling, autoclaving, fermentation, genetic manipulation and other processing methods without altering the nutritional value of food (Thakur and Kumar, 2017).

Phytic acid was highest in unprocessed mung bean followed by unprocessed pearl millet, germinated mung bean, blanched pearl millet and sorghum. The polyphenol content of all grains ranged from 203.42 to 739.43 mg/100 g. The results of phytic acid content in present study in mung bean (758.40 mg/100 g) and pearl millet (754.19 mg/100 g) are in agreement with those reported by Tarun (2014) and Kulthe *et al*. (2016), respectively. Pearl millet had the highest amount of polyphenol (739.43 mg/100 g). Polyphenol content of pearl millet varieties ranged from 502.78 to 658.30 mg/100 g as reported by Anju (2005). Germination of mung bean and blanching of pearl millet cause the significant reduction in phytic acid (487.84 mg/100 g) and polyphenol content (546.50 mg/100 g), respectively. The blanching of pearl millet was found to reduce phytic acid and polyphenol contents from 34-39 and 14-29%, respectively (Bhati *et al*., 2016: Demissew and Meresa, 2017; Krishnan and Meera, 2018). Singh *et al*. 2014 reported that phytic acid and polyphenol content reduced in germinated mung bean.

Table 3: *In vitro* digestibility of grains.

Grains	*In vitro* digestibility	
	Protein (%)	Starch (mg maltose released/g)
Pearl millet	53.16±0.06	20.68±0.06
Blanched pearl millet	56.07±0.09	22.71±0.09
Sorghum	70.02±0.09	32.96±0.03
Mung bean	59.81±0.09	24.36±0.03
Germinate mung bean	87.22±0.01	28.96±0.06
CD (P<0.05)	0.02	0.01

Values are mean±SE of three independent determinations.

Table 4: Anti-nutrient contents of grains (mg/100g, dry weight basis).

Grains	Anti-nutrients	
	Phytic acid (mg/100 g)	Polyphenol (mg/100 g)
Pearl millet	754.19±0.09	739.43±0.03
Blanched pearl millet	461.76±0.09	546.50±0.07
Sorghum	340.29±0.01	719.03±0.01
Mung bean	758.40±0.03	406.31±0.03
Germinate mung bean	487.84±0.02	293.03±0.02
CD (P<0.05)	0.03	0.05

Values are mean±SE of three independent determinations.

CONCLUSION

In conclusion, processing *i.e.* blanching of pearl millet and germination of mung bean improve the nutrition quality of food grains. Germinated mung bean had higher content of protein, total soluble sugar, non-reducing sugar and *in vitro* protein digestibility and lower content of phytic acid and polyphenol. Blenching of pearl millet reduces the phytic acid and polyphenol content and improves the starch digestibility. Sorghum was good in terms of total carbohydrate, starch, *In vitro* starch digestibility and lower amount of phytic acid.

REFERENCES

AOAC. (2000). Official Methods of Analysis. Association of Official Analytical Chemist. Washington, D.C.

Anju (2005). Nutritional evaluation and product development from white and yellow pearl millet varieties. M.Sc. Thesis, CCSHAU, Hisar, India.

Badubi, S.S. (2012). Nutritive evaluation of four sorghum cultivars grown in Botswana. UNISWA J. of Agric. 16: 49-54.

Bhati, D., Bhatnagar, V. and Acharya, V. (2016). Effect of pre-milling processing techniques on pearl millet grains with special reference to *in vitro* iron availability. Asian J. Dairy Food Res. 35: 76-80.

Çakir,O., Uçarli, C., Tarhan, C., Pekmez, M. and Kara, N.T. (2019). Nutritional and health benefits of legumes and their distinctive genomic properties. Food Sci. Technol. 39(1): 1-12.

Chavan, J.K. and Kachare, D.P. (1994). Effect of seed treatment on lipolytic deterioration of pearl millet flour during storage. J. Food Sci. Technol. 31(1): 80-81.

Chitra, U., Singh, U. and Rao, P.V. (1997). Effect of varieties and processing methods on the total and ionizable iron contents of grain legumes. J. Agric. Food Chem. 45(10): 3859-3862.

Clegg, K.M. (1956). The application of anthrone reagent to the estimation of starch in cereals. J. Sci. Food. Agri. 7: 40-44.

Dahiya, P.K., Linnemann, A.R., Khetarpaul, N., Grewal, R.B. and Nout, M.J.R. (2015). Mung bean: Technological and nutritional potential. Food Science and Nutrition. 55: 670-688.

Demissew, A. and Meresa, A. (2017). Evaluation of anti-nutritional factor reduction techniques for pearl millet improved utilization system in Amhara region. Inter. J. of Agri. And Bio. Sci. 30-38.

Elkonin, L.A., Italianskaya, J.V., Fadeeva, I.Yu., Bychkova, V.V. and Kozhemyakin, V.V. (2013). *In vitro* protein digestibility in grain sorghum: Effect of genotype and interaction with starch digestibility. Euphytica. 193: 327-337.

Fayyaz, N., Mohebbatmohebbi and Milani, E. (2018). Effect of germination on nutrients, mineral, phytic acid and enzyme activity of mung bean. Acta Medica Mediterranea. 34: 597

Gupta, N, Srivastava, A K., Pandey, V.N. (2012). Biodiversity and nutraceutical quality of some indian millets. Proceedings of the National Academy of Sciences, India Section B: Biological Science.

Kakati, P., Deka, S.C., Kotoki, D. and Saikia, S. (2010). Effect of traditional methods of processing on the nutrient contents and some antinutritional factors in newly developed cultivars of green gram [*Vigna radiata* (L.) Wilezek] and black gram [*Vigna mungo* (L.) Hepper] of Assam, India. Int. Food Res. J. 17: 377-384.

Krishnan, R. and Meera, M.S. (2018). Pearl millet minerals: Effect of processing on bioaccessibility. J Food Sci Technol. 55(9): 3362-3372.

Kulthe, A.A., Thorat, S.S. and Lande, S.B. (2016). Characterization of pearl millet cultivars for proximate composition, minerals and anti-nutritional contents. Advances in Life Sciences. 5(11): 4672-4675.

Lorensen, E., Prevosto, R. and Wilson, K.A. (1981). The appearance of new active forms of trypsin inhibitor in germinating mung bean (*Vigna radiata*) seeds. Plant Physiol. 68: 88-92.

Mertz, E.T., Kirleis, A.W. and Sxtell, J.D. (1983). *In vitro* digestibility of protein in major food cereals. Fed. Proc. 32(5): 6026 phospho-tungstic acid reagents. Am. J. Ecology Viticulture. 16: 144-158.

Noha, A., Mohammed, A., Mohamed, I.A. and Babiker, E. (2011). Nutritional evaluation of sorghum flour during processing of Injera. World Academy of Science, Engineering and Technology. 5.

Ogbonna, A.C., Abuajah, C.I., Ide, E.O. and Udofia, O.A. (2012). Effect of malting conditions on the nutritional and anti-nutritional factors of sorghum grist. Food Technology. 36(2): 64-72.

Olu, M., Alamu, A.E. and Oluwajoba, S.O. (2013). The effect of sprouting on the *in vitro* digestibility of maize and cowpea. J. Adv. Lab. Res. Biol. 4(2): 82-86.

Patni, D. and Agrawal, M. (2017). Wonder millet- pearl millet, nutrient composition and potential health benefits - A review. International J. of Innovative Res. and Review. 5(1): 6-14.

Paul, T., Mozumder, N.H.M.R., Sayed, M.A. and Akhtaruzzaman, M. (2011). Proximate composition, mineral contents and determination of protease activity from green gram. Bangladesh Res. Pubs. J. 5: 207-213.

Polak, R., Phillips, E.M. and Campbell, A. (2015). Legumes: health benefits and culinary approaches to increase intake. Clinical Diabetes Journals. 3(4): 198-205.

Singh, P.K., Gautam, A.K., Panwar, H., Singh, D.K., Srivastava, N., Bhagyawant, S.S. and Upadhayay, H. (2014). Effects of Germination on Antioxidant and Anti- Nutritional Factors of Commonly Used Pulses. Int. J. of Res. in Chem. and Environment. 4(2): 100-104.

Singh, U. and Jambunathan, R. (1981). Studies on *desi* and kabuli chickpea (*Cicer arientinum*) cultivars: Level of protease inhibitors, levels of polyphenolic compounds and *in vitro* digestibility. J. Food Sci. 46: 1364-1367.

Singh, U., Khedekar, M.S. and Jambunathan, R. (1982). Studies on desi and kabuli chickpea cultivars: The level of amylase inhibitors, level of oligosaccharides and *in vitro* starch digestibility. J. Food Sci. Tech. 47: 510-516.

Somogyi, M. (1945). A new reagent for determination of sugers. J. Biol. Chem. 160: 61-62.

Souilah, R., Djabali, D., Belhadi, B., Mokrane, H., Boudries, N. and Nadjem, B. (2014). *In vitro* starch digestion in sorghum flour from Algerian cultivars. Food Science and Nutrition. 2(3): 251-259.

Swain, J. and Hills, W.E. (1959). The phenolic constituents pramus domestical. The qualitative analysis of phenolic constituents. J. Sci. Food. Agric. 10: 63-68.

Tarun (2014). Nutritional evaluation of mung bean (*Vigna radiata*) varieties and their utilization in development of value added products. M. Sc. Thesis. CCS Haryana Agricultural University, Hisar, India.

Thakur, H. N. S. and Kumar, P. (2017). Anti-nutritional factors, their adverse effects and need for adequate processing to reduce them in food. Agric International. 4(1): 56-60.

Uppal, V. and Bains, K. (2012). Effect of germination periods and hydrothermal treatments on *in vitro* protein and starch digestibility of germinated legumes. J Food Sci Technol. 49(2): 184-191.

Yemm, E.W. and Willis, A.J. (1954). The estimation of carbo hydrates in plant extract by anthrone. Biochem. J. 54: 508-509.

Yi-Shen, Z., Shuai, S. and Gerald, R.F. (2018). Mung bean proteins and peptides: nutritional, functional and bioactive properties. Food and Nutrition Research. 60: 1290.