Int.J.Curr.Microbiol.App.Sci (2020) *9*(12): 2044-2056

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 12 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.912.241

Comparative Analysis of Nutritional Value, Glycemic Index and Sensory Quality of Barnyard Millet and Rice Varieties and their Products

Shweta Joshi[1]* and Sarita Srivastava[2]

[1]Department of Food Technology, Uttaranchal University, Premnagar, Dehradun, Uttarakhand, Postal code- 248007, India
[2]Department of Foods & Nutrition, College of Home Science, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, Postal code- 263145, India

**Corresponding author*

Keywords

Barnyard millet, Rice, Nutrition, Sensory, Glycemic index, Diabetes

Article Info

Accepted:
14 November 2020
Available Online:
10 December 2020

A B S T R A C T

Millets due to its difficult processing were left behind cereal grains like rice and wheat. But increasing number of life style disorders has again made the human race to realise the importance of millets in maintaining wellbeing. Objectives: To compare the nutritional value of barnyard millet and rice varieties and sensory quality and glycemic index of their products. Materials and Methods: Two varieties of barnyard millet (PRJ-1 and local cultivar) and two varieties of rice, Swarna (MTU-7029) and *Mahsuri* (BPT-5204) were procured. Proximate composition was analysed using AOAC (1995) procedure. Estimation of dietary fibre, resistant starch, tannic acid and antioxidant activity of barnyard millet was determined using the method given by Asp and Johanson (1981), McCleary *et al.,* (2002), AOAC (1970) and Zhang and Hamauzu (2004) respectively. Sensory quality and glycemic index evaluation of products was done using 9 point Hedonic scale and score card method given by Amerine *et al.,* (1965) and Wolever (1990) respectively. Results and Conclusion: The nutrition value of barnyard millet is significantly higher than rice varieties except for carbohydrate total physiological value. The sensory quality of food products (jeera jhangora, jeera rice, barnyard millet *khichdi* and Rice *khichdi*) shows non-significant difference. The Glycemic index of barnyard millet products (*jeera jhangora*) was significantly low then rice products (*jeera* rice) ranging from 35.9 (PRJ-1) - 39.5 (local cultivar) and 64.9 (*Swarna*)-73.9 (*Mahsuri*).The glycemic index of barnyard millet *khichdi* and Rice *khichdi* also show significant difference i.e. 34.96 (PRJ-1) and 62.50 (*Swarna*) respectively. The study thus concludes that barnyard millet products can be better utilized for their high nutritive value, low glycemic index value in life style diseases like diabetes as compared to rice. Recommendation: Barnyard millet can be a best substitute of rice for people suffering from diabetes owing to its low glycemic index, high nutritional value and similar (as rice) sensory characteristics.

Introduction

Rice is a cereal grain, which belongs to the grass species *Oryza sativa*. Among cereals, rice is the chief grains consumed in India. It is a staple food for 65% of Indian population especially in the eastern and southern parts of the country. Rice is essential and important part of nearly every Indian meal and it is grown on a majority of the rural farms. India ranks first in producing rice in world and accounts for 20% of all world rice production (India, 2009). Being cereal grain rice is a rich source of carbohydrates which acts as fuel for the body and aids in the normal functioning of the brain. Rice is fair source of various B vitamins, many of which have a major role in the development and optimal functioning of the nervous system (Nagdeve, 2019).

Along with these positive aspects white rice has long been known to have a negative effect on blood sugar. Like most "white" foods, it causes blood sugar spikes due to its high glycemic index (GI) value (Health, 2019). The Glycemic Index (GI) is a relative ranking of carbohydrate in foods according to how they affect blood glucose levels. Carbohydrates with a low GI value are more slowly digested, absorbed and metabolised and cause a lower and slower rise in blood glucose. Foods with a high GI are quickly digested and absorbed, causing a rapid rise in blood sugar. These foods that rank high on the GI scale. Due to high GI value rice becomes a restricted cereal for diabetics. On contrary millets ranks low in GI scale making them suitable for consumption in diabetic state.

Millets are considered as "ancient super grains" and the reservoirs of nutrition. These crops are adapted to wide range of agro climatic conditions and their short growing periods make them super food of present and future. All millet varieties show high antioxidant activity. Above all, Millet's high protein content makes up for energy deficiency in vegetarian diet (Indian Institute of Millet Research, 2019).

Barnyard millet (*Echinochloa frumantacea*) is mainly grown in the hilly areas of Uttaranchal, India. This is the fastest growing crop, which can produce ripe grains within 45 days from the sowing time under optimal weather conditions. The other names of barnyard are *shyama* in Bengali, *moraiyo* in Gujarati, *sanwa* in Hindi, *oodalu* in Kannada, *kuthiraivolly* in Tamil and *udalu* in Telugu. The barnyard is a wholesome grain over common cereal grains like rice, wheat.

The millet is nature's gift to the modern diet and sedentary activities that can lead to lifestyle disorders. Barnyard millet is a good source of highly digestible protein. Some varieties of barnyard millet have shown to contain high amounts of iron (18.6 mg in 100g of raw millet) which was the richest amongst all millets and cereal grains. It is an excellent source of dietary fibre with a good amount of both soluble and insoluble fractions. Millets with a serve providing 2.4 grams of fibre, the dietary fibre content of barnyard millet was high (12.6%) including soluble (4.2%) and insoluble (8.4%) fractions (Surekha *et al.*, 2013). The high fibre content plays major role in improving high blood sugar level. Barnyard seeds have relatively low carbohydrate content having slow digestibility. The carbohydrate content of barnyard is low (58.56%) and slowly digestible, making the barnyard millet a low glycemic index food. The carbohydrates in barnyard show a high degree of retrogradation of amylase, which facilitate the formation of higher amounts of resistant starch (Sudhanshu, 2018). Above all one major point that barnyard millet hold is that it is cooked similar to rice thus can be a good substitute of rice for diabetic patients. In today's scenario barnyard millet becomes one of the ideal foods for diabetics.

Materials and Methods

The present study has been carried out in the department of Foods and Nutrition, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India. For the present investigation, two type of samples of barnyard millet, variety PRJ-1 and local cultivar were procured from Pauri garhwal, Uttarakhand while the two varieties of rice, *Swarna* (MTU-7029) and *Mahsuri* (BPT-5204) were procured from Breeders Seed Production Center, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.

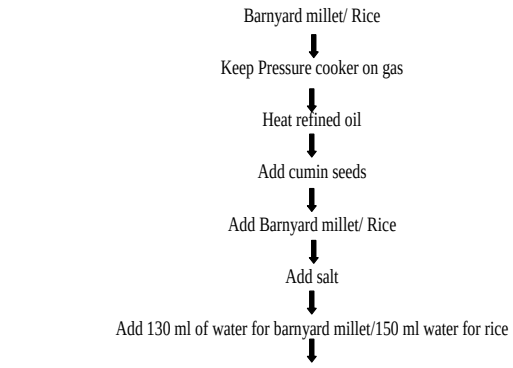
The proximate composition of barnyard millet and rice varieties was determined as per AOAC (1995) procedure. This involves the determination of the per cent of moisture, crude protein, total ash, crude fat, crude fibre, carbohydrate by difference and physiological energy. Estimation of dietary fibre was done using the method given by Asp and Johanson (1981).Resistant starch yield was determined by using the glucose oxidase assay given by McCleary *et al.*, (2002) with slight modification. Tannic acid was estimated by colorimetric method according to the procedure given by AOAC (1970). The antioxidant activity was estimated using the method of Zhang and Hamauzu (2004) with some modifications

Formulation, sensory and glycemic index evaluation of food products

Jeerajhangora and *Jeera* rice

Jeera jhangora similar to *jeera* rice was formulated using barnyard millet *Jeerajhangora* was formulated using PRJ-1 and local cultivar of barnyard millet and *jeera* rice was prepared using rice varieties *Swarna* and *Mahsuri* as shown in Table 1.

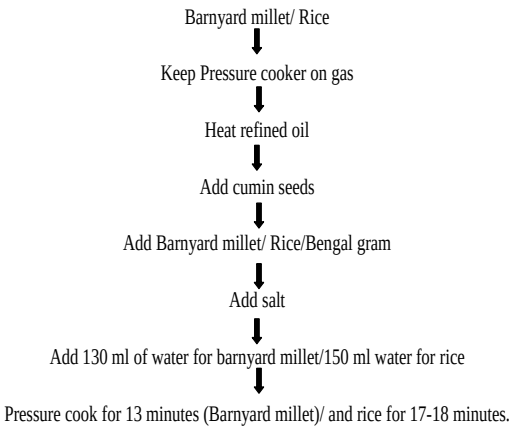
Preparation method of jeera jhangora/ jeera rice



Formulation of Barnyard millet *khichdi*/ Rice *khichdi*

Out of two samples of barnyard millet *viz.*, PRJ-1 variety and local cultivar, PRJ-1 variety showed lower glycemic index whereas in rice samples *viz*; *Swarna* and *Mahsuri*, variety *Swarna* showed lower glycemic index. Hence PRJ-1 variety of barnyard millet and *Swarna* variety of rice were taken for formulation of *khichdi* whose ingredients are listed in Table 2. The ratio of cereal to legume (Bengal gram *dhal*) taken was 5:1 (ICMR, 2010).

Preparation method of barnyard millet/Rice *Khichdi*



Sensory quality and glycemic index evaluation of barnyard millet and rice products

The sensory quality of *jeera jhangora* was done using 9-point Hedonic scale and score card method given by Amerine *et al.*, (1965). Glycemic index (GI) of barnyard millet was calculated according to the formula given by Wolever (1990).

$$GI = \frac{\text{Incremental area under blood glucose response curve for food product}}{\text{Corresponding area after equicarbohydrate portion of glucose}} \times 100$$

Results and Discussion

Nutritional composition of Barnyard millet and Rice varieties

Proximate analysis results indicate that barnyard millet varieties had significantly higher proximate values as compared to rice varieties except for carbohydrate and physiological energy as shown in Table 3.

The moisture content, crude protein, crude fat, crude fibre, total ash, total carbohydrate and physiological energy of PRJ-1 and local cultivar of barnyard millet were 11.86, 10.58, 3.5, 7.5, 2.06, 64.50 per cent and 332 Kcal/100g and 10.48, 9.39, 2.0, 6.3, 2.23, 69.60 per cent 334 Kcal/100g, respectively. Among rice varieties the moisture content, crude protein, crude fat, crude fibre, total ash, total carbohydrate and physiological energy of *Swarna* and *Mahsuri* were 10.30, 6.22, 2.10, 0.50, 0.73, 80.27 per cent and 364 Kcal/100g and 11, 6.57, 0.51, 0.22, 0.53, 81.23 per cent and 356 Kcal/100g, respectively. Except crude protein all proximate values of rice varieties differed significantly.

Alike the proximate composition, Barnyard millet varieties had significantly higher values of total dietary fibre, resistant starch and tannin content as compared to rice varieties as shown in Table 4. Among two barnyard millet samples PRJ-1 had significantly higher value of total dietary fibre (13.20%) resistant starch (14.23%) and tannin content (78%) as compared to local cultivar having 11.4, 12.81 and 67.8 per cent of total dietary fibre, resistant starch and tannin content, respectively.

Ugare *et al.*, (2014) and Veena *et al.*, (2005) reported total dietary fibre content in barnyard millet as 12.60 per cent (IDF (8.36%) and SDF (4.24%) and 12.84% (IDF (8.18%) and SDF (4.6%)), respectively. Soluble fibre helps in moderating blood glucose levels and lowering of cholesterol whereas insoluble fibre does not absorb or dissolve in water. It passes through our digestive system in close to its original form. Insoluble fibre offers many benefits to intestinal health, including a reduction in the risk and occurrence of hemorrhoids and constipation) (Slavin, 2008). Resistant starch when present in significant amounts, lowers the calorific density of food and infer low glycemic response) (Jenkins *et al.*,1982).Total dietary fibre, resistant starch and tannin content of rice varieties *Swarna* and *Mahsuri* were 2.96, 1.59, 26.2 per cent and 1.92, 0.98 and 24.4 per cent, respectively.

Millets are known to contain a wide range of phenolic compounds which are good sources of natural antioxidants. The antioxidant activity of barnyard millet samples under study was 62.15 per cent for PRJ-1 and 59.23 per cent for local cultivar. Singh and Naithani (2014) reported that the DPPH activity of barnyard millet was 495 mcg/ml. The total antioxidant activity of rice varieties was 24.84 per cent for *Swarna* and 19.26 per cent for *Mahsuri* as shown in Fig. 1.

Sensory quality and glycemic index of food products

Barnyard millet was used in formulation of *jeera jhangor* and *khichdi.* These were

compared with similar food products prepared from rice for their sensory quality and glycemic index.

Jeera jhangora and jeera rice

PRJ-1 and local cultivar of barnyard millet were used for formulating *jeera jhangora* while *Swarna* and *Mahsuri* variety of rice were used for formulating jeera rice. No spices were used for preparing *jeera jhangora* and *jeera* rice to avoid their effect on glycemic index value of barnyard millet and rice. Only small amount of *jeera* and salt were used with a purpose of increasing organoleptic value of *jeera jhangora* and *jeera* rice. Both *jeera jhangora* and *jeera* rice were compared for sensory quality and glycemic index.

Sensory quality of jeera *jhangora* and *jeera rice* using score card method and Nine-point Hedonic Scale

Sensory evaluation of*jeera jhangora* and *jeera* rice was done by panel of 10 members from Department of Foods & Nutrition. The panel members were experienced in the respective fields. They were healthy and free from diseased condition.

Sensory evaluation is important criteria in judging the acceptability of food product. As shown in Table 5 the overall acceptability of *jeera jhangora* prepared using PRJ-1 and local cultivar of barnyard millet was 7.8 whereas the overall acceptability of *jeera rice* was 8.2 for *Swarna* variety and 8.1for *Mahsuri* variety of rice. *Jeera jhangora* and *jeera* rice, both fall under "Good" category of score card and statistically no significant difference was found between sensory quality of *jeera jhangora* and *jeera* rice. The result of Nine Point Hedonic scale depicts non-significant difference between sensory characteristics of *jeera jhangora* and *jeera* rice (Table 6).

Glycemic index of *jeera jhangora* and *jeera rice*

The amount containing 50 g of carbohydrate used for formulating *jeera jhangora* using PRJ-1 and local cultivar was 78 and 71.83g, respectively and amount containing 50 g of carbohydrate used for formulating *jeera* rice using *Swarna* and *Mahsuri* was 62.28 and 61.55g, respectively. Consumption of high-glycemic index (GI) foods result in more rapid as well as higher increase in blood glucose levels as opposed to consumption of low-glycemic (GI) index foods (Ludwig, 2002).

Significant difference was observed in glycemic index between barnyard millet and rice food product (*jeera jhangora* and *jeera* rice) and also between *jeera jhangora from* PRJ-1 and local variety as well as between *Jeera* rice from *Swarna* and *Mahsuri* variety (Table 7). The *jeera jhangora* from PRJ-1 variety showed the lowest glycemic index value (35.9) followed by *jeera jhangora* from local cultivar (39.5). According to Brand – Miller *et al.,* (1999) the foods having glycemic index less than 55 are considered low glycemic index foods. Foods having glycemic index between 56-69 are considered as medium glycemic index foods whereas foods having glycemic index more than 70 and above are considered as high glycemic index foods. The glycemic index values of *jeera jhangora* prepared from both varieties of barnyard millet lie under low glycemic index foods category and thus both are suitable for diabetics. Ugare *et al.*, (2014) in their study reported that plain barnyard millet meal (without any hypoglycemic agent) exhibited a significantly low glycemic index of 41.7.

The value of glycemic index of *Jeera* rice prepared from *Mahsuri* variety and *Swarna* was 73.9 and 64.9, respectively. The glycemic index of *Mahsuri* was higher than *Swarna*.

According to the classification given by Brand – Miller *et al.*, (1999) *Swarna* falls in medium ranged glycemic index foods whereas *Mahsuri* falls under high glycemic index foods. Thus, it is very much clear from Table 7 and Figure 2 that the high glycemic index of jeera rice (varieties *Swarna* and *Mahsuri*) makes it unsuitable for consumption in diabetic condition.

Sensory quality of Barnyard millet *khichdi* and rice *khichdi*

Khichdi using barnyard millet and legume (Bengal gram) was formulated and compared with rice *khichdi* for sensory characteristics and glycemic index.

After determination of glycemic index of *jeera jhangora* and *jeera* rice using barnyard millet and rice samples, the variety having lowest glycemic index was used for preparation of *khichdi*. Thus PRJ-1 variety of barnyard millet and *Swarna* variety of rice with Bengal gram dhal in ratio of 5:1 (cereal:legume) (ICMR, 2010) were used for formulating *khichdi*. The purpose of adding legume was to know how much legume will further affect the glycemic index of food.

Sensory quality of barnyard millet *khichdi* and rice *khichdi* using score card method and 9 Point Hedonic Scale

Persual of Table 8 indicates that there was no significant difference in the sensory characteristics of *khichdi* prepared from barnyard millet (variety PRJ-1) and rice (variety *Swarna*). The overall acceptability of barnyard millet *khichdi* and rice *khichdi* was 8 and 8.1, respectively on scale of 10.

Hedonic scale rating depicts non-significant difference between *khichdi* prepared from barnyard millet (variety PRJ-1) and rice (variety *Swarna*). Both were under "liked very much" category of Hedonic scale (Table 9).

Table.1 Ingredients used for preparing jeerajhangora/jeera rice

Ingredients	Amount
	Barnyard millet varieties/Rice Varieties
Barnyard millet	100 g
Salt	1.10 g
Jeera	0.50 g
Oil	½ tsp
Water	130 ml

tsp=tea spoon

Table.2 Ingredients used in preparation of *khichdi* using barnyard millet and rice

Ingredients	Amount	
	Barnyard millet(varietyPRJ-1)	**Rice (variety *Swarna*)**
Barnyard millet /rice	65g	54g
Bengal gram dhal	13 g	10.8g
Salt	1.10g	1.10g
Jeera	0.50g	0.50g
Oil	½ tsp	½ tsp
Water	130ml	150ml

Table.3 Proximate composition of barnyard millet and rice

S.No.	Proximate Composition (per 100g)	Barnyard millet		Rice		S.Em	CD at 5%
		Variety PRJ-1	Local cultivar	Variety *Swarna*	Variety *Mahsuri*		
		Dry wt basis	Dry wt basis	Dry wt basis	Dry wt basis		
1	**Crude protein (%)**	12±0.23	10.48±0.23	6.93±0.03	7.33±0.12	0.12	0.39
2	**Crude fat (%)**	3.97±0.08	2.23±0.04	2.34±0.05	0.56±0.04	0.01	0.03
3	**Crude fibre (%)**	8.50±0.01	7.03±0.06	0.55±0.02	0.24±0.04	0.02	0.06
4	**Total ash (%)**	2.33±0.03	2.49±0.05	0.81±0.03	0.59±0.07	0.03	0.12
5	**Carbohydrate (%)**	73.17±0.04	77.7±0.01	89.48±0.03	90.73±0.05	0.01	0.03
6	**Physiological energy (Kcal)**	376±0.03	380±0.05	407±0.03	397±0.04	1.19	3.8

Table.4 Total dietary fibre, resistant starch and tannin content of barnyard millet and rice

S.No	Nutrients (g/100g)	Barnyard millet		Rice		S.Em	CD at 5%
		Variety PRJ-1	Local cultivar	Variety *Swarna*	Variety *Mahsuri*		
1	**Total dietary fibre**	13.2^{a}±0.01	11.4^{b}±0.03	2.96^{c}±0.02	1.92^{d}±0.04	0.01	0.04
a	**Insoluble**	8.7±0.01	7.9±0.04	2.01±0.01	1.09±0.01		
b	**Soluble**	4.5±0.01	3.5±0.01	0.95±0.02	0.83±0.02		
2	**Resistant starch**	14.23^{a}±0.04	12.81^{b}±0.07	1.59^{c}±0.02	0.98^{d}±0.03	0.028	0.09
3	**Tannin**	78^{a}+0.04	67.8^{b}±0.05	26.2^{c}±0.09	24.4^{d}±0.05	0.03	0.11

All results are mean±SD for three individual determinations S.Em – standard error of mean, CD – critical difference, a,b,c,d= significant difference between samples of barnyard millet and rice for different variables

Table.5 Sensory quality of *jeera jhangora* and *jeera* rice using score card method

S.No	Characteristic	*Jeera jhangora* (mean±SD)		*Jeera* rice (mean±SD)		S.Em	CD at 5%
		PRJ-1	Local	*Swarna*	*Mahsuri*		
1	Colour	7.7±0.82	7.8± 0.63	8±0.47	8± 0.81	0.22	0.63
2	Aroma	7.7± 0.73	7.8±0.56	7.9± 0.42	7.9±0.63	0.19	0.55
3	Taste	7.9±0.52	7.9±0.67	8.3±0.82	8.1±0.73	0.24	0.68
4	Appearance	7.8±0.51	7.9±0.48	7.9±0.87	7.9±0.63	0.22	0.64
5	Overall acceptability	7.8±0.67	7.8±0.48	8.2±0.67	8.1±0.73	0.19	0.55

S.Em – standard error of mean, CD – critical difference

Table.6 Sensory quality of *jeera jhangora* and *jeera rice* using nine point Hedonic scale

S.No.	Food product	Mean ±SD	Preference
1	***Jeera jhangora***		
a	PRJ-1	7.8±0.42	Like moderately
b	Local	7.9±0.51	Like moderately
2	***Jeera* rice**		
a	*Swarna*	8±0.47	Like very much
b	*Mahsuri*	8±0.31	Like very much
	S.Em	0.21	
	CD at 5%	0.61	

S.Em – standard error of mean, CD – critical difference

Table.7 Glycemic index of *jeera jhangora* and *jeera rice*

S.No	Food product	Glycemic index (mean±SD)
1.	**Barnyard millet (*Jeera jhangora*)**	
a	PRJ-1	35.9±2.35
b	Local	39.5±2.25
2	**Rice (*Jeera* rice)**	
a	*Swarna*	64.9±1.38
b	*Mahsuri*	73.9±2.30
	S.Em	0.66
	CD at 5%	1.91

S.Em – standard error of mean, CD – critical difference

Table.8 Sensory quality of *khichdi* prepared from PRJ-1 variety of barnyard millet and *Swarna* variety of rice using score card

S.No.	Characteristics	Barnyard millet *khichdi* (mean±SD)	Rice *khichdi* (mean±SD)	t-value	S/NS
1	**Colour**	**7.8±0.84**	**8.2± 0.42**	**0.47**	**NS**
2	**Aroma**	**7.9± 0.70**	**8±0.47**	**0.55**	**NS**
3	**Taste**	**8±0.67**	**8.1±0.52**	**0.42**	**NS**
4	**Appearance**	**8±0.63**	**8±0.73**	**-**	**NS**
5	**Overall acceptability**	**8±0.67**	**8.1±0.52**	**0.28**	**NS**

S& NS stands for significant difference and non significant difference, respectively

Table.9 Sensory quality of *khichdi* prepared from PRJ-1 variety of barnyard millet and *Swarna* variety of rice using nine point Hedonic scale

S.No	Food product	Score (Mean ±SD)	Preference
1	**Barnyard millet *khichdi***	8.1±0.67	Like very much
2	**Rice*khichdi***	8.3±0.67	Like very much
	t-value	0.43	
	S/NS	NS	

S& NS stands for significant andnon-significant difference, respectively

Table.10 Glycemic index of barnyard millet *khichdi* and rice *khichdi*

S.No.	Food product	Glycemic index (mean±SD)
1	**Barnyard millet *khichdi***	34.96±1.22
2	**Rice *khichdi***	62.50 ±1.38
	t-value	4.67
	S/NS	S

S& NS stands for significant and non significant difference, respectively

Fig.1 Total antioxidant activity of barnyard millet and rice in per cent

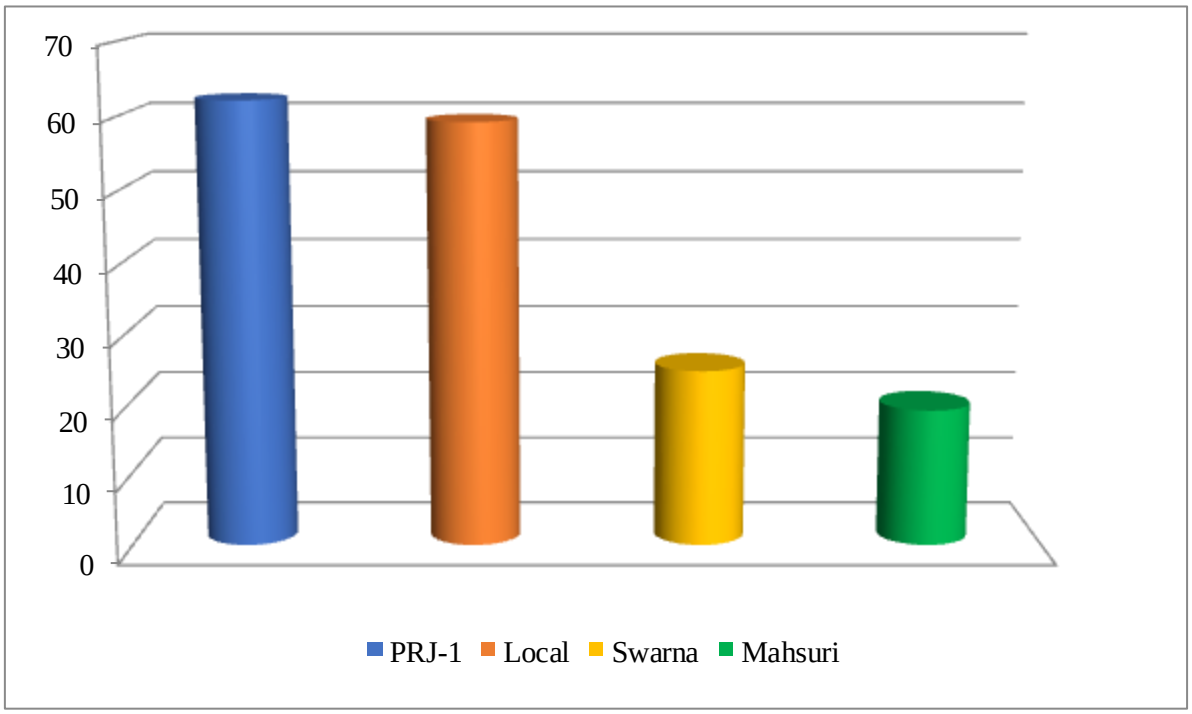


Fig.2 Blood glucose response curve for Jeera jhangora (PRJ-1 and Local cultivar) and Jeera rice (variety Swarna and Mahsuri) in comparison to glucose load of 50g

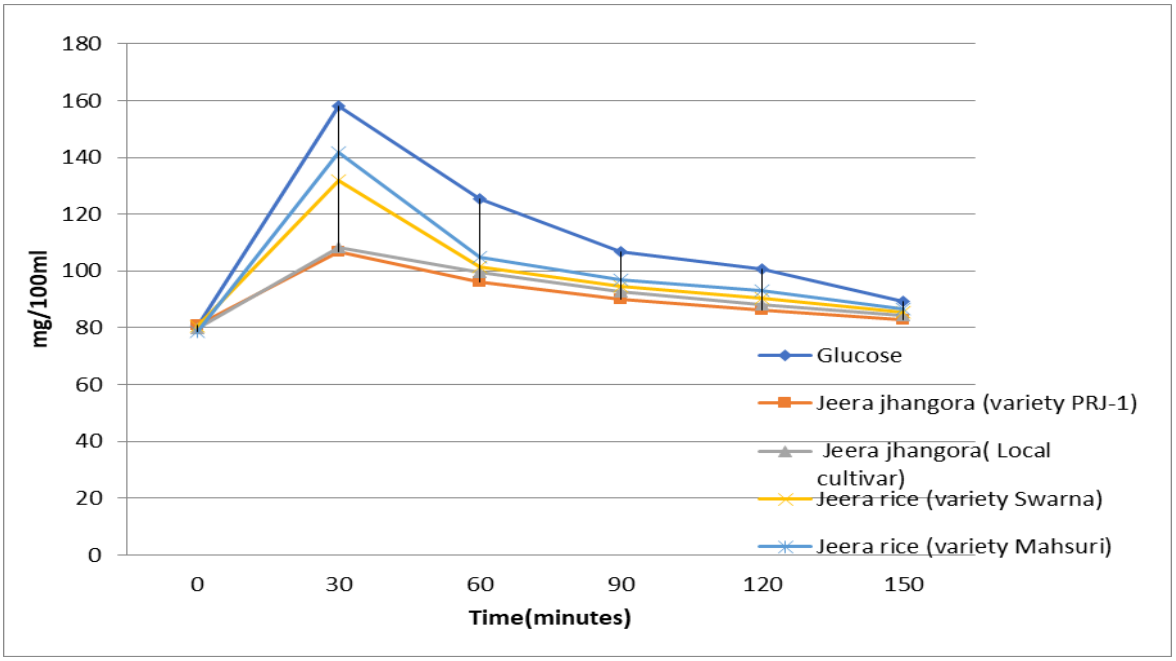
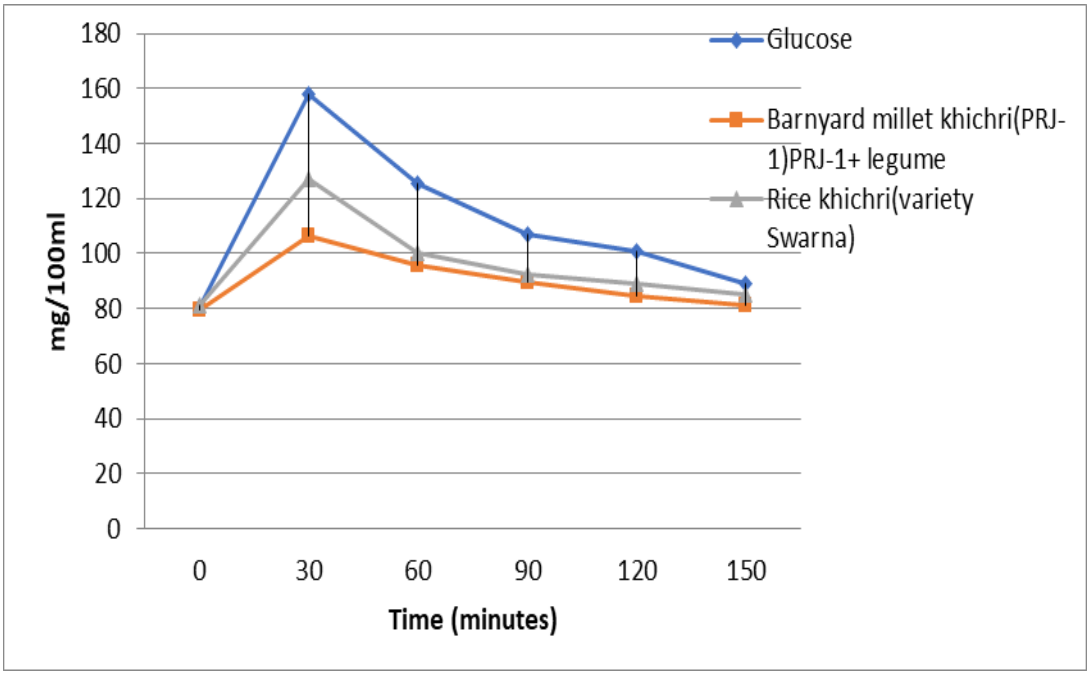


Fig.3 Blood glucose response curve for barnyard millet khichdi (variety PRJ-1) and rice khichdi (variety Swarna) in comparison to glucose load of 50g



Glycemic index of barnyard millet *khichdi* and rice *khichdi*

Bengal gram dhal contains 20.8 per cent protein. Studies have shown that protein when added to carbohydrate test meals decrease blood glucose response and enhance insulin secretion

It is clear from Table 10 and Figure 3 that rice *khichdi* had significantly higher glycemic index (62.50) as compared to barnyard millet *khichdi* (34.96).

Hence concluded, as depicted by the results it is much clear that barnyard millet varieties had higher nutritional value as compared to rice varieties. The preparation of simple recipes using both millet and rice is done because these can be easily consumed daily as well as easily prepared as compared to other products prepared using millets like *laddu,Halwa*. So, the products prepared in the study are simple/easy to prepare and a healthy option as compared to rice. The results on sensory quality of the products prepared from barnyard millet and rice depicts a non-significant difference between them which clearly suggest that instead of rice barnyard millet can be successfully consumed with pulses (Dal- chawal) which in India is a must meal out of three. Furthermore adding more positive points in barnyard millet pocket the results on Glycemic index of food products prepared using barnyard millet and rice clearly suggest that the rice products has higher glycemic index which makes it unsuitable for diabetic patients, whereas the barnyard millet products *jeera jhangora* and *khichdi* have low glcemic index value suitable for diabetic patients.

Acknowledgement

The authors acknowledge Department of Foods and Nutrition, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand for

providing all the facilities and guidance during the course of research work and Department of Science and Technology (New Delhi) for providing financial assistance through INSPIRE fellowship programme.

References

Amerine, N.A., Pangborn, R.M. and Roessler, E.B. 1965. Principles of sensory evaluation of food. New York. Academic Press.

AOAC. 1970. Official methods of analysis of the association of official analytical chemists. 11th ed. Washington D. C., U. S. A

AOAC. 1995. Official methods of analysis of the association of official analytical chemists. 16th ed. Washington D. C., U. S. A.

Asp, N.G. and Johansson, C.G. 1981.Techniques of measuring dietary fiber: principle aims of method and comparison of results obtained by different techniques. In: James, W.P.T and Theander, O.eds. The analysis of dietary fibre in the food. New York. Basel. Marcel Dekker. Inc. p. 173-190.

Brand-Miller. J, Wolever. T.M.S. Colagiuri, S. and Foster-Powell, K. 1999. The glucose revolution. New York. Marlowe and Company.

Health, 2019. https://www.everydayhealth. com/type-2-diabetes/diet/healing-and-healthy-foods/

India (2009). A Country Study: Crop Output". Library of Congress, Washington D.C. September. http://www.velavanstores.com/Rice-in-India.asp

Indian Institute Of Millet Research IIMT (2019). http://www.millets.res.in/ millets.php

Jenkins, D.J., Wolever, T.M., Leeds, A.R., Gassull, M.A., Haisman, P., Dilawari, J., Goff, D.V., Metz, G.L. and Alberti, K.G. 1978. Dietary fibres, fibre analogues, and glucose tolerance: Importance of viscosity. *British Medical Journal*.1:1392–1394.

McCleary, B.V., McNally, M and Rossiter, P. 2002. Measurement of resistant starch by enzymatic digestion in starch and selected plant materials. Collaborative study. *Journal of AOAC International.* 85:1103-1111.

Nagdeve, M. (2019). Incredible Benefits of Rice. https://www.organicfacts.net/health-benefits/cereal/health-benefits-of-rice.html

Singh, M. And Naithani, M. 2014. Phytochemical estimation and antioxidant activity of seed extract of millets traditionally consumed by common people of Uttarakhand, India. *International Journal of Biology, Pharmacy and Allied Sciences*. 3(10): 2389-2400

Slavin, J.L. 2008. Position of the American Dietetic Association: health implications of dietary fiber. *Journal of American Dietetic Association*. 108(10): 1716-1731.

Sudhanshu (2018). Barnyard Millet: The Rice For Diabetic Patients.https://madtyapost.com/barnyard-millet-the-rice-for-diabetic-patients/

Surekha, N., Devi, R., and Naik, R.S. 2013. Development of value added low glycemic index barnyard millet (*Echinochloa frumentacea* Link) noodles. *International Journal of Food and Nutritional Sciences*. 2(3):20-24.

Ugare, R., Chimmad, B., Naik, R., Bharati, P. and Itagi S. 2014. Glycemic index and significance of barnyard millet (*Echinochloa frumentacae*) in type II diabetics. *Journal of Food Science and Technology*. 51(2): 392-395.

Veena, B., Chimmad, B.V., Naik, R.K. and Shantakumar, G. 2005. Physico-

chemical and nutritional studies in barnyard millet. *Karnataka Journal of Agriculture Sciences*. 18 (1): 101-105.

Wolever, T.M. 1990. The glycemic index. *World Review of Nutrition and Dietetics*. 62: 120-185.

Zhang, D. and Hamauzu, Y. 2004. Phenolics, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking. *Food Chemistry*. 88: 503-508.

How to cite this article:

Shweta Joshi and Sarita Srivastava. 2020. Comparative Analysis of Nutritional Value, Glycemic Index and Sensory Quality of Barnyard Millet and Rice Varieties and their Products. *Int.J.Curr.Microbiol.App.Sci*. 9(12): 2044-2056. doi: https://doi.org/10.20546/ijcmas.2020.912.241