

ASSESSMENT OF FERMENTATION EFFECT ON PHYSICO-CHEMICAL PROPERTIES OF PEARL MILLET FLOUR

SWETA SINGH^{1*}, AJAY KUMAR SINGH², HARISON MASI³ AND KUNAL SINGH⁴

Department of Processing and Food Engineering,
Sam Higginbottom University of Agriculture, Technology & Sciences
Prayagraj 211 007, U.P., India

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Abstract–The present study was undertaken to evaluate various physicochemicals of different pearl millets varieties (NANDI 65 and PIONEER 8885) proximate analysis like, moisture, protein, fat, ash, carbohydrate were evaluated. Fermentation at 24 hrs, 48 hrs and 72 hrs and pure culture *Lactobacillus fermentum* (MTCC 903) was performed. Analysis revealed increase in moisture content and fat content and a decrease in carbohydrate and protein content during fermentation.

INTRODUCTION

Millet is a nutritionally good and occupies a place in the diet of human beings in lots of areas of the world. Although millets are nutritionally advanced to cereals their usage as a meal continues to be mostly limited to the conventional customers and populace of decrease monetary strata. The unique functions of the millets, their usefulness and fitness consciousness of the customer have made scientists and engineers to increase diverse meals merchandise and mechanize the processes. There are diverse conventional and comfort meals which include ready-to-eat (RTE) meals merchandise advanced from millets. Millet is predominately starch wealthy with the protein aspect like that of sorghum, wheat and corn. Millets have copious fibre and may be as excessive as 20% of the general grain composition. Millet is a generic term used for small sized grains that shape heterogeneous organization and referred together with maize and sorghum as 'coarse cereals'. Their agricultural importance arises from their hardness, tolerance to excessive climate and will be grown with low inputs in low rainfall areas (Taylor, 2004).

Pearl millet (*Pennisetum glaucum*) indicates that it is a good source of energy, protein, nutrients and minerals (Osman, 2009). However, bioavailability of the vitamins is constrained because of the presence

of anti-dietary elements together with phytic acid, tannins, goitrogens, oxalic acid and trypsin inhibitors. These compounds intervene with mineral bioavailability, carbohydrates and protein digestibility via inhibition of proteolytic and amylolytic enzymes. The phytic acid is gift with inside the germ whereas, polyphenols are in peripheral regions of the pearl millet grain (Simwemba *et al.*, 1984). Phytic acid has a robust capacity to chelate multivalent steel ions, mainly zinc, calcium, iron and as with protein residue. The binding can bring about insoluble salts with bad bioavailability of minerals (Coulibaly *et al.*, 2011). Hence, it's far vital to reduce the phytic acid and polyphenols to avail the dietary advantages of this grain. Pearl millet grain is mild in weight (3-15mg) however has a proportionally large germ (17.4%) than all different cereal grains, besides maize (Taylor, 2004). It carries a higher content of triglycerides, that are good in unsaturated fatty acids. Pearl millet flour used for meals like *roti* (flat bread), *bhakri* (stiff *roti*) and porridge or gruel is produced with the aid of milling, either via conventional or mechanical processes. However, pearl millet flour turns bitter and rancid some days because of lipolysis and next oxidation of the ensuing de-esterified unsaturated fatty acids (Lai and Varriano-Marston, 1980).

(*Research Scholar¹, Assistant Professor², Associate Professor³ Research Scholar⁴)

Pearl millet (*Pennisetum glaucum*) is a versatile cereal cultivated for food, feed and forages (Arora *et al.*, 2011) particularly in African and Asian countries (Nambiar *et al.*, 2011). At drought and high temperature conditions it has the capability to survive which further increases its potential to be grown in those regions where wheat, maize and other cereal crops fail to persist. Among all the millet varieties, greater than 29 million hectare area is occupied by pearl millet; however, its distribution is restricted geographically mainly in Africa (15 million) and also Asia is about 11 million, as being the largest producer (Rathore *et al.*, 2016). More than 95 per cent pearl millet production comes from developing countries, and out of total world production India as the largest producer (Basavaraj *et al.*, 2010) covers an area of 9.8 million hectares (Rathore *et al.*, 2016). When compared to the major cultivated cereal crops such as rice, wheat and sorghum (Kavitha and Parimalavalli, 2014) Protein content of pearl millet had higher value (14.0 per cent), fat (5.7 per cent), fiber (2.0 per cent) and ash (2.1 per cent) content (Sade, 2009). In their successful utilization for various traditional as well as convenience health foods the processing of millets had yielded promising results. Accordingly Popped, flaked, puffed product had tried by different researchers to develop processed products. Fermented, malted and composite flours; weaning foods, etc are the extruded and roller dried product.

Germination and probiotic fermentation causes improvement in protein profile and in-vitro mineral availability. Probiotics are “lives microorganisms” and according to FAO/WHO where is administered confer health benefits though, this have to additionally specify genus, species and strain level, Extrusion of weaning ingredients of pearl millet will increase the protein digestibility.

By antibiotics, chemotherapy or disease bacteria levels are reduced. To improve the body’s resistance against pathogens microorganisms most of probiotic foods generate fatty acids, vitamins and other vital nutrients (Arora *et al.*, 2011).

If fermentation is finished with probiotic organisms, it could convey precise introduced advantages dietary improvement. Specific bacteria, mainly the species of lactobacilli compose the bulk of recommended probiotics (Goldin and Gorbach, 1992). In addition to their dietary value during fermentation, probiotic organisms have wonderful consequences on metabolism improvement, constipation reduction, and cholesterol reduction.

MATERIALS AND METHOD

Materials: Two varieties of pearl millet Nandi 65 and Pioneer 8885 were obtained from Sheoran Krishi Kendra Loharu. District. Bhiwani Haryana. cultures of *Lactobacillus fermentum* were obtained from MTCC 903) Institute of Microbial Technology, Chandigarh, India.

Method of preparation

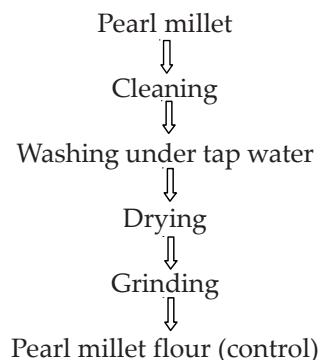


Fig. 1. Flow chart for Preparation of Pearl millet (control) flour

Physico chemical analysis

Moisture content

At first weight of empty previously dried (1 hr. at 100 °C) crucible with cover was taken and 5g of sample was placed on it. Then the crucible was placed in an air tray (thermostatically controlled) and dried at temperature of 100 to 105 °C for 24 hrs. After drying, the crucible is removed from the oven and cooled in desiccator. It is then weighed with cover glass. The crucible is again placed in the oven, dried for 30 minutes, took out of the dryer, cooled in desiccator and weighed. Drying, cooling, and weighing were repeated until the two consecutive weights were the same. The resultant loss in weight was calculated as % moisture content, A.O.A.C. (2000). From these weights the % of moisture in food samples will be calculated as follows.

$$\text{Moisture (\%)} = \frac{\text{Loss of weight}}{\text{Weight of sample}} \times 100$$

Protein content determined by kjeldahl method

The Micro kjeldahl method described by A.O.A.C. (2000) was used to determine the crude protein. 2g of each of the samples was mixed with 10 ml of concentrated H₂SO₄ in a heating tube. 2-3g of catalyst the mixture was added to the tube and

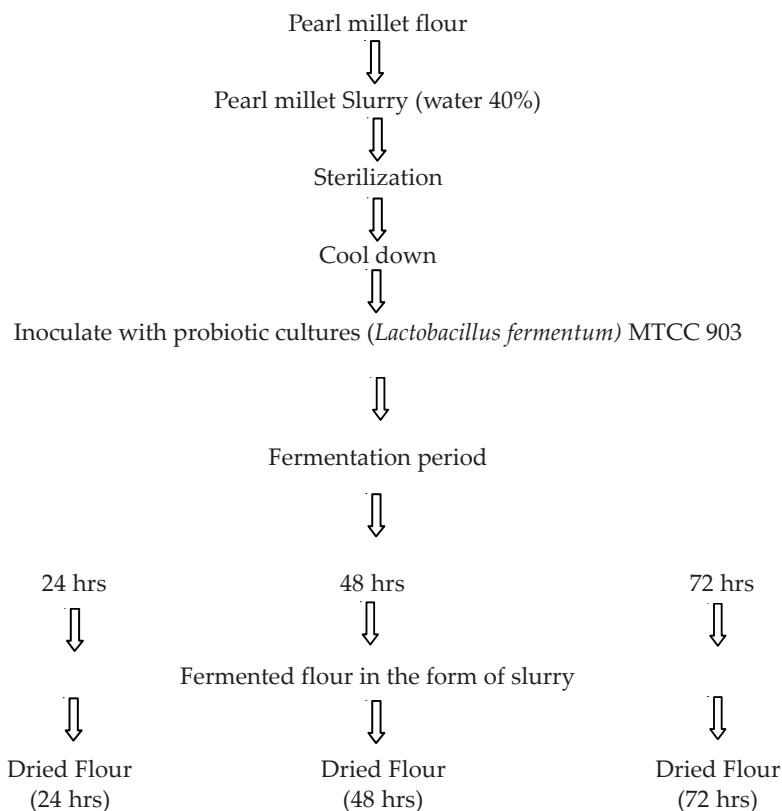


Fig. 2. Flow chart Preparation of fermented Pearl millet flour (NANDI 65 and PIONEER 8885)

mixture heated. The digest was transferred into distilled water. 10 ml portion of the digest mixed with equal volume of 40% NaOH solution and poured into a micro kjeldahl distillation apparatus. The mixture is distilled and the distillate collected into 2% boric acid solution containing Bromocresol green and methyl red indicator in ratio of 1:5. A total of 50ml distillate was collected and titrated as well. The sample were taken and the average duplicate values of the calculated. The Nitrogen content calculated and multiplied with 6.25 to attain the crude protein content.

$$\text{Nitrogen (\%)} = \frac{(100 \times N \times 14 \times VF) T}{100 \times V}$$

$$\text{Protein (\%)} = \text{Nitrogen (\%)} \times 6.25$$

Where

N= Normality of the titrate (0.1N)

VF= Total volume of the digest= 100ml

Crude Fat

Crude Fat was determined by Soxhlet method. Five gram of sample was weighed and placed in an oven for one hour. Dried sample after moisture

determination was then transferred to thimble and then the top of the thimble was plugged with cotton. This thimble is then dropped into the fat extraction soxhlet apparatus tube attached to soxhlet flask. Petroleum ether (about 75 ml or more) was then poured through the sample in the tube into flask. Then condenser was attached to the fat extraction tube. Extraction was carried out for 6-8 hours or longer. At the end of extraction, thimble was removed from the apparatus and the flask was heated for some time so that ether present in extracted fat gets evaporated. It was then cooled for some time and then the fat containing flask was weighed. Crude fat can be calculated using formula A.O.A.C. (2000).

$$\text{Crude Fat (\%)} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{weight of sample}} \times 100$$

Ash content

The ash content of the samples was determined by using Muffle furnace was followed by A.O.A.C. (2000). 5g of the sample was taken and weighed in silica crucible. It was then transferred to muffle furnace and the temperature was raised to 600°C

and kept for 6 hours until white ash was obtained. After cooling the weight was taken and the percentage of ash was calculated from the weight difference.

$$\text{Ash \%} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

Carbohydrate AAAC, (2000) method

The crude protein (kjeldhal*6.25), fat solvent extraction, crude fibre, ash and moisture were determined according to AACC (2000) methods. The carbohydrate content of each sample were determined by differences

$$\% \text{Carbohydrate} = (\% \text{moisture} + \% \text{protein} + \% \text{crude fibre} + \% \text{fat} + \% \text{Ash})$$

RESULTS AND DISCUSSION

Moisture content

The approximate composition of fermented and unfermented pearl millet is shown below in Table 1. indicating that the moisture content of fermented pearl millet flour was significantly higher than the unfermented flour. This could be attributed to the duration (24, 48, and 72 hours) of fermented samples. Moisture content of fermented flour for nandi 65 at 72 hours had $12.42 \pm 0.1\%$ which is higher than for 24 hours and higher than for 48 hours, i.e. 11.92 ± 0.20 , $12.26 \pm 0.12\%$. The moisture content of unfermented pearl millet pioneer 8885 flour is 7.44 ± 0.33 which is lower than the moisture content of fermented flour in 24 hours which is lower than the moisture content of fermented 48 hrs pearl millet pioneer 8885. The moisture content of pearl millet fermentation increased moisture content.

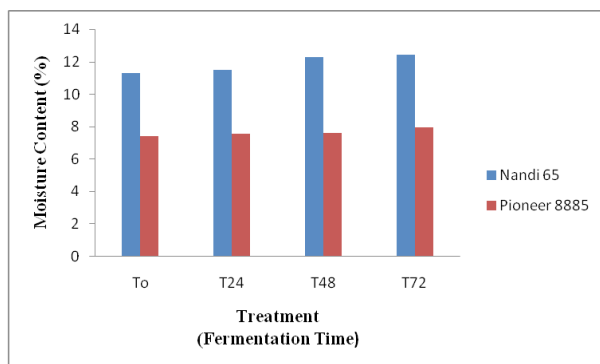


Fig. 3. Moisture content (%) of pearl millet flour (Nandi 65 and Pioneer 8885)

Protein content

The protein content of PIONEER 8885 fermented flour at 72 hours of fermentation had $6.21 \pm 0.17\%$, which is lower than the protein content of 48 hours, i.e. $7.96 \pm 0.08\%$ respectively. In pioneer 8885 protein content was found more as compared to nandi 65 as shown in Table 2 (T₀, T₂₄, T₄₈, T₇₂). A decrease in protein content was observed after fermentation. The decrease may be due to destruction of amino acid due to heat.

Decreased protein catabolism by fermenting microorganisms may account for loss of protein by escaping ammonia, a by-product of metabolic deamination. Some strains of bacteria are known to possess deaminases (Khetarpaul *et al.*, 1989).

Fat content

Fat content of the fermented pearl millet flour pioneers 8885 was significantly lower than that of the unfermented flour nandi 65. Fat content of fermented flour pioneer 8885 at 72 hours is $3.56 \pm$

Table 1. Moisture content (%) of different flour varieties of pearl millet

Fermentation Period	Moisture content	
	Nandi 65	Pioneer 8885
T ₀	11.32 ± 0.17	7.44 ± 0.33
T ₂₄	11.48 ± 0.20	7.58 ± 0.05
T ₄₈	11.92 ± 0.12	7.62 ± 0.54
T ₇₂	12.42 ± 0.1	7.98 ± 0.50

Note: -T₀ Non fermented, T₂₄ Fermented at 24 hours, T₄₈ Fermented at 48 hours, - T₇₂ Fermented at 72 hrs
Mean ± standard deviation, values within a column followed by moisture content (NANDI 65 and PIONEER 8885) was found significant at 5% level of significance

Table 2. Protein content (%) of different flour varieties of pearl millet

Fermentation Period	Protein content	
	Nandi 65	Pioneer 8885
T ₀	7.23 ± 0.37	8.33 ± 0.27
T ₂₄	6.98 ± 0.20	7.59 ± 0.06
T ₄₈	6.42 ± 0.61	7.96 ± 0.08
T ₇₂	6.28 ± 0.27	6.21 ± 0.17

Note: T₀ Non fermented, T₂₄ Fermented at 24 hours, T₄₈ Fermented at 48 hours, - T₇₂ Fermented at 72 hrs
Mean ± standard deviation, values within a column followed by protein content (NANDI 65 and PIONEER 8885) was found significant at 5% level of significance

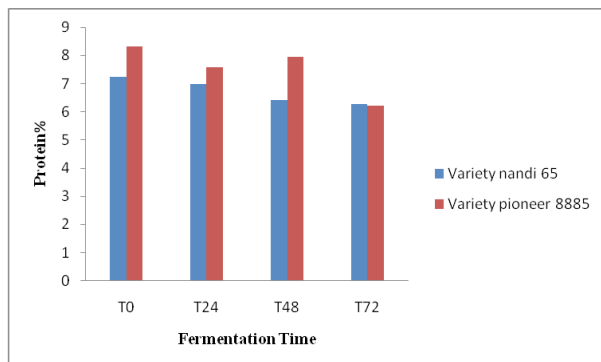


Fig. 4. Protein content (%) of pearl millet flour (Nandi 65 and Pioneer 8885)

0.28 % which is higher than the fermented flour 24 hours and 48 hours, i.e. 3.15 ± 0.20 and 3.44 ± 0.46 %. The relatively lower values were recorded during fermentation for total fat could have been due to breakdown of fat molecules during fermentation. Khetarpaul *et al.*, (1989)

Ash content

The ash content of flour pioneer 8885 before

Table 3. Fat content (%) of different flour varieties of pearl millet

Fermentation Period	Fat content	
	Nandi 65	Pioneer 8885
T ₀	6.14 ± 0.16	2.15 ± 0.16
T ₂₄	5.38 ± 0.34	3.15 ± 0.20
T ₄₈	7.50 ± 0.27	3.44 ± 0.46
T ₇₂	5.19 ± 0.21	3.56 ± 0.28

Note: -T₀ Non fermented, T₂₄ Fermented at 24 hours, T₄₈ Fermented at 48 hours, - T₇₂ Fermented at 72 hrs

Mean \pm standard deviation, values within a column followed by fat content (NANDI 65 and PIONEER 8885) was found significant at 5% level of significance

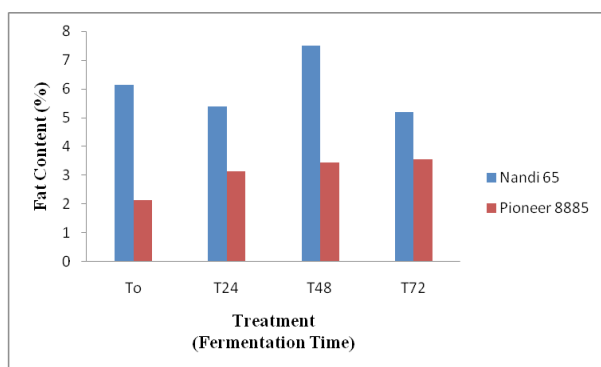


Fig. 5. Fat content (%) of pearl millet flour (Nandi 65 and Pioneer 8885)

fermentation (control) was 1.35 ± 0.23 %. The results showed that the ash content of fermented pearl millet flour pioneer 8885 was significantly lower in 72 hours of fermentation. This could be attributed to the temperature and duration (24 hrs, 48 hrs, and 72 hrs) of fermented samples. Reduction in ash content especially in fermented samples may be attributed to losses due to leaching of soluble inorganic salts. Olaghenga Olufemi Awolu (2017). The ash contents indicates mineral content of the product.

Carbohydrate content

The carbohydrate content of flour pioneer 8885 before fermentation (control) ranged 74.8 ± 0.13 %. The results showed that the carbohydrate content of the fermented pearl millet flour pioneer 8885 was significantly lower than that of the unfermented flour. This could be attributed to the duration of fermented samples (24 hours, 48 hours, and 72 hours). The carbohydrate content of fermented flour pioneer 8885 at 72 hours fermentation was found to be 72.58 ± 0.4 % which is lower than 24 and 48 hours,

Table 4. Ash content (%) of different flour varieties of pearl millet

Fermentation Period	Ash content	
	Nandi 65	Pioneer 8885
T ₀	1.33 ± 0.25	1.35 ± 0.23
T ₂₄	1.44 ± 0.22	1.45 ± 0.28
T ₄₈	1.48 ± 0.02	1.55 ± 0.11
T ₇₂	1.28 ± 0.11	1.44 ± 0.11

Note: -T₀ Non fermented, T₂₄ Fermented at 24 hours, T₄₈ Fermented at 48 hours, - T₇₂ Fermented at 72 hrs

Mean \pm standard deviation, values within a column followed by Ash content (NANDI 65 and PIONEER 8885) was found significant at 5% level of significance

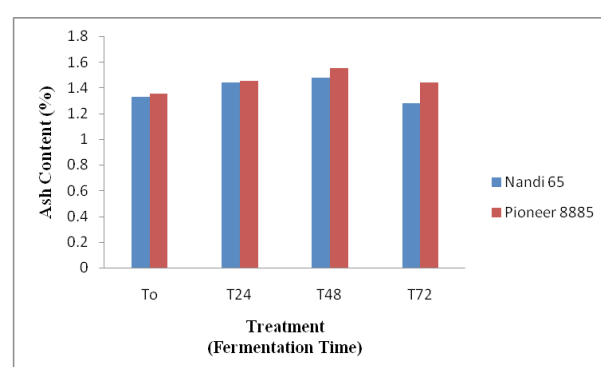


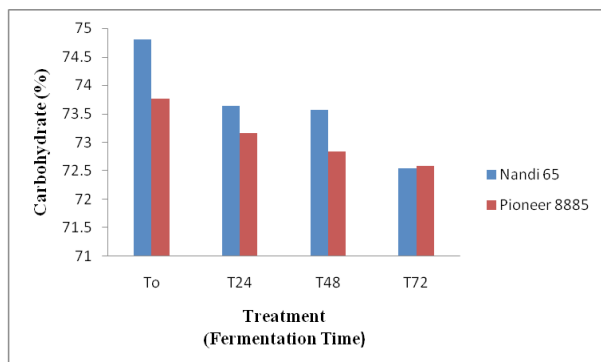
Fig. 6. Ash content (%) of pearl millet flour (Nandi 65 and Pioneer 8885)

Table 5. Carbohydrate content (%) of different flour varieties of pearl millet

Fermentation Period	Carbohydrate content	
	Nandi 65	Pioneer 8885
T ₀	74.8 ± 0.13	73.76 ± 0.67
T ₂₄	73.64 ± 0.49	73.16 ± 0.24
T ₄₈	73.57 ± 0.54	72.84 ± 0.15
T ₇₂	72.54 ± 0.5	72.58 ± 0.4

Note: -T₀ Non fermented, T₂₄ Fermented at 24 hours, T₄₈ Fermented at 48 hours, - T₇₂ Fermented at 72 hrs
Mean ± standard deviation, values within a column followed by Carbohydrate content (NANDI 65 and PIONEER 8885) was found significant at 5% level of significance

i.e 73.16 ± 0.24 % and 72.84 ± 0.15% respectively. Almost same values seen in both the varieties was observed. Lowering of carbohydrate during fermentation. According to Simwemba *et al.*, (1986) decrease in carbohydrates level is probably due to the utilization by microorganisms. The initial drop in carbohydrate content was attributed to the action of microbial α - and β -amylase.

**Fig. 6.** Carbohydrate content (%) of pearl millet flour (Nandi 65 and Pioneer 8885)

pH content

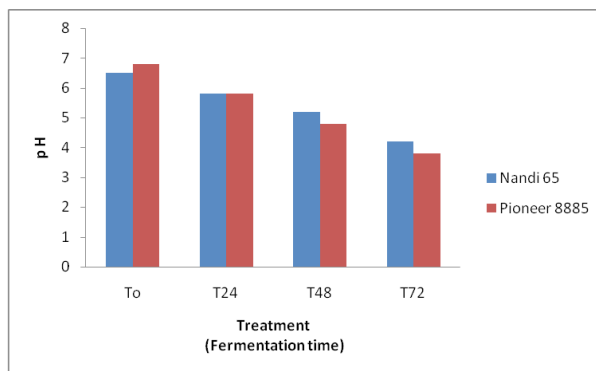
The results showed that the pH content of the fermented pearl millet flour in both the varieties lower than that of the unfermented flour. This could be attributed to the duration of fermented samples (24 hours, 48 hours, and 72 hours). The pH content of fermented flour pioneer 8885 at 72 hours fermentation was found to be 3.8±0.20 which is lower than 24 and 48 hours, i.e 5.8±0.20 and 4.8±0.10. Fermentation was found to cause a gradual reduction in a pH with time Giese (1994) who reported that, as a result of fermentation, the

Table 6. pH content of different flour varieties of pearl millet

Fermentation Period	pH	
	Nandi 65	Pioneer 8885
T ₀	6.5±0.15	6.8±0.16
T ₂₄	5.8±0.20	5.8±0.20
T ₄₈	5.2±0.10	4.8±0.10
T ₇₂	4.2±0.11	3.8±0.20

Note: -T₀ Non fermented, T₂₄ Fermented at 24 hours, T₄₈ Fermented at 48 hours, - T₇₂ Fermented at 72 hrs
Mean ± standard deviation, values within a column followed by pH content (NANDI 65 and PIONEER 8885) was found non significant at 5% level of significance

increased acidity and low pH enhances the keeping quality of millet foods.

**Fig. 7.** pH content of pearl millet flour (Nandi 65 and Pioneer 8885)

CONCLUSION

Millets are nutritionally rich and occupy an essential area in the food plan of people in many areas of the world. Although millets are nutritionally advanced to cereals their usage as a meals continues to be more often than not confined to the traditional consumers. The unique features of the millets, their uses and health focus of the customer have made food scientists and engineers to expand numerous food products. culture fermentation with probiotic organisms had been elective in improving the dietary quality of the developed food product. Pearl millet (Bajra) (*Pennisetum glaucum*) is a rich supply of vitamins compared to the major cultivated cereal crops.

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