The Pharma Innovation Journal 2020; 9(2): 05-08

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(3): 05-08

www.thepharmajournal.com
Received: 03-01-2020
Accepted: 07-02-2020

Pawar PP
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Sawate AR
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Kshirsagar RB
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Agarkar BS
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Pawar PP
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Studies on physicochemical properties of finger millet (*Eleusine coracana*) and pearl millet (*Pennisetum glaucum*)

Pawar PP, Sawate AR, Kshirsagar RB and Agarkar BS

Abstract
The present investigation was carried out to study the physical and chemical properties of finger millet and pearl millet. Physical properties such as 1000 kernel weight, porosity, bulk density, true density, angle of repose were determined. Moisture content, protein, fat and carbohydrates were also evaluated. Further, chemical composition was reported and results showed that the moisture content 10.6 percent, fat 1.50 percent carbohydrate 72.3 percent, protein 7.5 percent and ash 3.10 percent were found in finger millet and moisture content 12.2 percent, fat 4.9 percent carbohydrate 67 percent, protein 11.5 percent and ash 2 percent were found in pearl millet. The study is significant for the designers and processers in designing equipment for processing. Results are likely to be beneficial in evaluating the quality of grains used for processing.

Keywords: Finger millet, pearl millet, physical properties, chemical properties

Introduction

Pearl millet (*Pennisetum glaucum*) is a versatile cereal cultivated for food, feed and for ages (Arora *et al.,* 2003) [2] particularly in African and Asian countries (Nambiar *et al.,* 2011) [18]. It has the capability to survive under drought and high temperature conditions 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 and Asia, as being the largest producer (Rathore *et al.,* 2016) [19]. More than 95 per cent pearl millet production comes from developing countries, and India as the largest producer (Basavaraj *et al.,* 2010) [4] covers an area of 9.8 million hectares out of total world production (Rathore *et al.,* 2016) [19].

Energy content of pearl millet is greater than sorghum and equivalent to brown rice due to its rich unsaturated fatty acids (75 per cent) and linoleic acid (46.3 per cent) contents (Jaybhaye *et al.,* 2014) [12]. Superior protein quality in term of its tryptophan and threonine content (Elyas *et al.,* 2002) [9] along with higher content of calcium, iron as well as zinc (Yadav *et al.,* 2014; Sade, 2009*;* Lestienne *et al.,* 2007) [26, 21, 15] makes this crop very useful for human.

Finger millet, (*Eleusine coracana* L.) is also known as ragi and mandua (India); It is an important staple food in parts of eastern and central Africa and India. Finger millet is extensively cultivated in various regions of India and in the entire world. India is the major producer of finger millet contributing nearly 60% of the global production (Kamini and Sarita, 2011) [13]. Finger millet is consumed without dehulling. It is better adapted in higher rainfall areas (600-1,200 mm) particularly to acid soils and matures within 100-130 days. One of the important features of this millet is its ability to adjust itself in different agro climatic conditions which reflects it having highest productivity among millets (Gopalan *et al.,* 2002) [11]. In India it is widely grown in the states of Karnataka, Tamil Nadu, Andhra Pradesh and parts of North India (Vijayakumari *et al.,* 2003) [25].

Finger millet stands unique among the cereals such as barley, rye and oats with higher nutritional contents and has outstanding properties as a subsistence food crop. Finger millet (*Eleusine coracana* L.) is one of the minor cereals, which is nutritionally significant in terms of high calcium, phosphorous, iron and zinc. Ten per cent of the world's 30 million tons of millet produced is finger millet (Dida *et al.,* 2008) [7]. In India, finger millet occupies the largest area under cultivation among the small millets (Chandra *et al.,* 2016) [5].

Finger millet (*Eleusine coracana L.*) is important millet grown extensively in various regions of India and Africa, constitutes as a staple food for a large segment of the population in these countries. It ranks sixth in production after wheat, rice, maize, sorghum and bajra in India. It is a naked caryopsis with brick red-coloured seed coat and is generally used in the form of the whole meal for preparation of traditional foods, such as roti (unleavened breads or pancake), mudde (dumpling) and ambali (thin porridge). Epidemiological studies have demonstrated that regular consumption of whole grain cereals and their products can protect against the risk of cardiovascular diseases, type II diabetes, gastrointestinal cancers and a range of other disorders (McKeown, 2002) [16].
Being indigenous minor millet this is used in the preparation of geriatric, infant food and health foods both in natural and malted forms.

Materials and Methods
The raw material were obtained from local village market, Parbhani. The proposed research was carried out in Department of Food Engineering, College of Food Technology, VNMKV, Parbhani.

Physical properties
Different physical properties such as thousand kernel weight, porosity, bulk density, true density and angle of repose were measured.

Thousand kernel weight
100 grain of each sample was randomly collected from various lots and weighed using electronic balance (corrected to 0.01g) at predetermined moisture content. The weight of sample was multiplied with 10 to obtain average thousand kernel weight (Bart-Plange *et al.,* 2012, Tavakoli *et al.,* 2010) [3, 23].

Porosity
Porosity was analyzed using the relationship of bulk density and particle density (Chhabra N. and Kaur A., 2017) [6].
$\varepsilon = (\rho b - \rho t / \rho t) \times 100$
ρb = bulk density
ρt = true density

Bulk density
Grains were filled in measuring cylinder up to certain level from the constant height followed by weighing. Bulk density is ratio of mass and volume. (Varnamkhasti *et al.,* 2008) [24].

$$\text{Bulk density} = \frac{\text{Weight of grains}}{\text{Volume display}}$$

True Density
The true density was measured by kerosene oil displacement method (Mohsenin, 1986) [17].

$$\text{True Density} = \frac{\text{Weight of grains}}{\text{Volume occupied}}$$

Angle of Repose
Angle of repose gives indication of nature of pile formed by the material. It is angle with respect to horizontal at which material stands when piled. The apparatus consists of hollow cylinder and plywood plate. The cylinder was filled with grains and inclined slowly allowing the grains to fall gradually until it was empty. The height and radius of assumed slope was measured using the scale. The average reading of triplicate was recorded for accuracy. (Firouzi and Alizadeh, 2012) [10].
$\Theta = \tan^{-1}(2h/d)$
h= height of slope
d= diameter

Proximate composition
Proximate Analysis
Different chemical properties of samples were analysed for moisture content, ash, fat, protein and total carbohydrate. All the determinations were done in triplicate and the results were expressed as the average value.

Moisture content
Moisture content was determined adopting AOAC (2005) [1] method as following:

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

Fat
AOAC (2005) [1] method using Soxhlet apparatus was used to determined crude fat content of the sample. The percent of crude fat was expressed as follows:

$$\%\ \text{Crude Fat} = \frac{\text{Weight of dried ether soluble material}}{\text{Weight of sample}} \times 100$$

Protein
Protein content was determined using AOAC (2005) [1] method. Percentage of nitrogen and protein calculated by the following equation:

$$\%\ \text{Nitrogen} = \frac{\text{TS - TB} \times \text{Normality of acid} \times 0.014}{\text{Weight of sample}} \times 100$$

Where, TS = Titre volume of the sample (ml),
TB = Titre volume of Blank (ml),
0.014= M eq. wt. of N_2.
% Protein = Nitrogen × 6.25

Total carbohydrate
Total carbohydrate content of the samples was determined as total carbohydrate by difference that is by subtracting the measured protein, fat, ash and moisture from 100 phenol sulphuric acid method as given by AOAC (2005) [1].

Ash
Drying the sample at 100 ^{0}C and charned over an electric heater. It was then ash in muffle furnace at 550 ^{0}C for 5 hrs. By AOAC (2005) [1]. It was calculated using the following formula:

$$\%\ \text{Ash content} = \frac{\text{AW}}{\text{IW}} \times 100$$

Where, AW = Weight of Ash
IW= Initial weight of dry matter

Result and Discussion

Physical properties

Different physical properties such as thousand kernel weight, porosity, bulk density, true density and angle of repose were measured and results obtained are presented in Table 1.

Table 1: Physical properties of pearl millet and finger millet

Physical Parameters	Observation	
	Pearl Millet	**Finger Millet**
1000 Kernel weight	10.1 gm	3.4 gm
Bulk density	0.83 gm/cm³	0.83 gm/cm³
True density	1.25 gm/cm³	1.39 gm/cm³
Porosity	33.6%	40.2%
Angle of repose	23°	27°

*Each value represents the average of three determinations

In similar research, (Chhabra N. and Kaur A., 2017) [6] and (Shivabasappa R.S. *et al.*, 2012) [22], has discussed and stressed upon the importance of these properties.

Chemical properties

Data pertaining to various chemical properties like moisture, fat, carbohydrates, protein, and ash were investigated and results obtained are depicted in Table 2.

Table 2: Chemical composition of pearl millet and finger millet

Chemical Parameters	Mean Value*	
	Pearl Millet (%)	**Finger Millet (%)**
Moisture	12.2±0.25	10.6 ± 1.23
Total Fat	4.9±0.21	1.50 ± 0.13
Total carbohydrates	67.0±0.50	72.3 ± 0.10
Protein	11.5±0.30	7.50 ±0.17
Ash	2.0±0.12	3.10 ± 0.11

*Each value represents the average of three determinations

Similar results were obtained by (Kumar A. *et al.*, 2016) [10].

Conclusion

Overall it can be concluded that the importance of studying physical properties are considered as the basic data in designing the machinery and equipment used during the harvesting and in the post-harvest such as storage operations. Importance of these properties in determining the size of the machines particularly that of the separation, transfer, and sorting equipment. Finally, it can be concluded from the results that pearl millet and finger millet are highly nutritious and make it potentially useful in preparation and value addition of food products. The grains of this millet are converted into flours for preparation of products like porridge, puddings, pancakes, biscuits, roti, bread and other snacks.

References

1. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists International. In: Horwitz, W. (Ed.), 18th Ed. AOAC Press, Arlington, VA, USA, 2005.
2. Arora P, Sehgal S, Kawatra A. Content and HCl-extractability of minerals as affected by acid treatment of pearl millet, Food Chemistry. 2003; 80(1):141-144.
3. Bart-Plange A, Dzisi KA, Ampah J. Effect of drying on selected physical properties of Asontem cowpea variety, International Scholarly Research Notices Agronomy, 2012, 1-7.
4. Basavaraj G, Rao PP, Bhagavatula S, Ahmed W. Availability and utilization of pearl millet in India, SAT eJournal. 2010; 8(1):1-6.
5. Chandra D, Chandra S, Pallavi and Sharma AK. Review of Finger millet (*Eleusine coracana* L.) A power house of health benefiting nutrients, Food Science and Human Wellness. 2016; 5(1):149-155.
6. Chhabra N, Kaur A. Studies on physical and engineering characteristics of maize, pearl millet and soybean. Journal of Pharmacognosy and Phytochemistry. 2017; 6(6):01-05.
7. Dida MM, Wanyera N, Harrison DML, Bennetzen JL, Devos KM. Population structure and diversity in finger millet (*Eleusine coracana*) germplasm, Tropical Plant Biology. 2008; 1(1):131-141.
8. Dutta SK, Nema VK, Bhardwaj RK. Physical properties of grain, Journal of Agricultural Engineering Research. 1988; 39(1):259–268.
9. Elyas SH, El-Tinay AH, Yousif NE, Elsheikh EA. Effect of natural fermentation on nutritive value and *in vitro* protein digestibility of pearl millet, Food Chemistry. 2002; 78(1):75-79.
10. Firouzi S, Alizadeh M. Effect of moisture content on selected physical characteristics of cowpea seed (*Vigna unguiculata* L. Walp), Annals Biological Research. 2012; 3(7):3583-3590.
11. Gopalan C, Ramashastri BV, Balasubramanium SC. Nutritive value of Indian foods. National Institute of Nutrition, ICMR, Hyderabad, 2002.
12. Jaybhaye RV, Pardeshi IL, Vengaiah PC, Srivastav PP. Processing and technology for millet based food products: a review, Journal of Ready to Eat Food. 2014; 1(2):32-48.
13. Kamini S, Sarita S. Quality characteristics of finger millet based baby food preparation as affected by its varieties and processing techniques, Journal of Functional and Environmental Botany. 2011; 1(1):77-84.
14. Kumar A, Metwal M, Kaur S, Gupta AK, Puranik S, Singh S. Nutraceutical value of finger millet (*Eleusine coracana* L.) and their improvement using Omics approaches, Frontiers in plant science, 2016, 7(1).
15. Lestienne I, Buisson M, Lullien-Pellerin V, Picq C, Trèche S. Losses of nutrients and anti-nutritional factors during abrasive decortication of two pearl millet cultivars (*Pennisetum glaucum*), Food Chemistry. 2007; 100(4):1316-1323.
16. McKeown NM. Whole grain intake is favorably associated with metabolic risk factors for type 2 diabetes and cardiovascular disease in the Framingham Offspring Study, American Journal of Clinical Nutrition. 2002; 76(1):390-398.
17. Mohsenin NN. Physical properties of plant and animal materials (2nd Ed.), Gordon and Breach Science Publishers, New York, 1986, 63-107.
18. Nambiar VS, Dhaduk JJ, Neha S, Tosha S, Rujuta D. Potential functional implications of pearl millet (*Pennisetum glaucum*) in health and disease, Journal of Applied Pharmaceutical Science. 2011; 1(10):62-67.
19. Rathore S, Singh K, Kumar V. Millet grain processing, uilization and its role in health promotion: a review, International Journal of Nutrition and Food Sciences. 2016; 5(5):318-329.
20. Rooney LW, Serna-Saldivar SO, Kulp K, Ponte J. Handbook of Cereal Science and Technology, Second Edition, 2000.

21. Sade FO. Proximate, antinutritional factors and functional properties of processed pearl millet (*Pennisetum glaucum*), Journal of Food Technology. 2009; 7(3):92-97.
22. Shivabasappa RS, Roopa bai, Sridevi H, Sharanagouda, Udaykumar N. Engineering properties of finger millet (*Eleusine coracana* L.) grains, International Journal of Agricultural Engineering. 2012; 5(2):178-181.
23. Tavakoli M, Tavakoli H, Rajabipour A, Ahmadi H, Gharib-Zahedi S. Moisture-dependent physical properties of barley grains, International Journal of Agricultural and Biological Engineering. 2010; 2(4):84-91.
24. Varnamkhasti MG, Mobli H, Jafari A, Keyhani AR, Soltanabadi MH, Rafiee S. Some physical properties of rough rice (*Oryza sativa* L.) grain, Journal of Cereal Science. 2008; 47(3):496-501.
25. Vijayakumari J, Mushtari BJ, Shamshad B, Sumangala G. Sensory attributes of ethnic foods from finger millet. Paper presented at CCSHAU, Hisar. Recent trends in millet processing and utilization, 2003, 7-12.
26. Yadav DN, Sharma M, Chikara N, Anand T, Bansal S. Quality characteristics of vegetable blended wheat pearl millet composite pasta, Agricultural Research. 2014; 3(3):263-270.