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Research paper

Comparative Study of Drying Characteristics of Finger Millet Germinated Vegetative Seed and Finger Millet and its Quality Evaluation

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ABSTRACT

In present study of finger millet malt flour and its quality evaluation was done. The drying characteristics were studied by the convective hot air drying method at the temperature of 45°C. The Physico-chemical properties of finger millet malt and finger millet flour like moisture, protein, fat, ash, fiber, carbohydrate, bulk density, water absorption capacity, wettability ranged from 5.6 ± 0.10 to 5.4±0.01, 6.43 ± 0.26 to 6.16±0.04, 1.18 ± 0.05 to 0.07±0.03, 1.5 ± 0.03 to 1.15±0.06, 3.75 ± 0.01 to 3.1±0.30, 81.57 ± 0.42 to 83.12±0.28, 0.606 ± 0.0 to 0.588±0.0, 2.94 ± 0.02 to 2.08±0.14, 41 ± 1.00 to 39±1.00 respectively. The study will help in decision making of using finger millet flour or malt in various cookies, biscuits, and functional foods preparation.

Keywords: Finger millet, finger millet malt, physico-chemical properties, functional properties

Finger millet (*Eleusine coracana*) also known as *ragi, nachani* or *nagli* is one of the important millet in India. The world production of millet grains in year 2013 was 762,712 metric tons and the top producer was India with an annual output of 334,500 tons contributing 43.85% (FAO, 2013). Finger millet ranks fourth in importance among millets after sorghum, pearl millet and foxtail millet (Upadhyaya *et al*. 2007). It is widely cultivated in Africa and South Asia under varies agro-climatic conditions and is estimated that some 10% of the world's 30 million tons of millets produced is finger millet (Dida *et al.* 2008). Presence of fine layered testa in finger millet makes it unique compared to other millet such as foxtail millet, pearl millet, kodo millet and proso millet. This could be one of the possible reasons for higher dietary fiber content in finger millet (FAO, 1995).

The nutraceutical importance of finger millet lies in its high content of calcium (0.38%), protein (6%-13%), dietary fiber (18%), carbohydrates (65-75%), minerals (2.5-3.5%), phytates (0.48%), tannins (0.61%), phenolic compound (0.3-3%), and trypsin inhibitory factors and is recognized for its health beneficial effects, such as anti-diabetic, antitumrogenic and antiulcer, anti-inflammatory, atherosclerogenic effects, antioxidant and antimicrobial properties. The polyphenols, phytates, tannins and dietary fiber content of finger millet contributes to antioxidant activities which is an important factor in resisting aging and metabolic

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diseases. Moreover finger millet is also useful in management of various physiological disorders such as diabetes mellitus, hypertension, vascular fragility, hypercholesterolemia, prevention of oxidation of low-density lipoproteins (LDLS) and also improves gastrointestinal health (Devi *et al.* 2014; Sripriya *et al.* 1996; Chetan and Malleshi, 2007; Thompson, 1993; Bravo, 1998; Scalbert *et al.* 2005).

Various processed products from finger millet are various traditional products such as *roti* (unleavened breads), *ambali* (thin porridge) and *mudde* (dumping). On daily consumption of whole grain of finger millet and its products can protect against the risk of cardiovascular diseases, type II diabetes, and gastrointestinal cancer and other health issues (Mc keown *et al.* 2002).

Drying involves a number of physical and chemical changes in the processed material (Gao *et al.* 2012; Alasalvar *et al.* 2013) the most important chemical reactions being enzyme activity deactivation or acceleration, color or vitamin oxidation and cell membrane denaturation (Tian *et al.* 2016) and the Maillard reactions (Michalska *et al.* 2016). Thus, developing an understanding of how drying induces the changes in the chemical composition of biological material, especially the content of biologically active compounds, could help in choosing the best drying method.

The simplest and most common method of drying is drying by convection: is carried out in the presence of a hot gas which transfers heat to the particles of the product, which is designed to pick up water vapor resulting from the processing of water in the gas phase. The hot air represents thermal agent and entrainment agent of moisture evaporated by the product. Heat and mass transfer during drying is conditioned by drying agent parameters (speed, temperature, relative humidity) and the relationship between humidity and product. (Veleșcu *et al*. 2013). The convection hot air dryer operates at atmospheric pressure under steady drying conditions using hot air as a drying medium and convection as mode of heat transfer (Mujumdar and Law, 2010).

Finger millet is important millet and its malting has been practices both at households and industrial level in India and some of the African Countries. Malted *ragi* flour, or extract derived from it, is extensively used in preparation of weaning foods, beverages or other pharmaceutical preparation (Nirmala *et al.* 2000). The main purpose of malting is to produce enzymes and to breakdown cell walls surrounding starch granules. One of the most important physico-chemical changes that occur during malting is the degradation of proteinaceous matrix that surrounds the starch granules within the cells of the endosperm and their conversion into soluble peptides and aluinoacids to provide substrates for synthesis of proteins in the growing embryo (Enej *et al.* 2003).

The various researchers reported the quality parameter of the Finger millet malt by convective hot air drying. Bau *et al*. (1997) reported that crude protein increase during malting could be because of synthesis of enzyme proteins or a compositional change following the degradation of other constituents during germination. Ash content represents the total mineral content. It is a part of proximate analysis for nutritional evaluation. Ash is the first step in preparing a sample for specific elemental analysis. Because certain samples are high in particular minerals, ash content becomes important (Nielsen, 2009). Water absorption capacity represents the ability of a product to associate with water under condition where water is limited (Singh, 2001). Water absorption capacity is important in the development of ready to eat foods and a high water absorption capacity may assure product cohesiveness (Ogunlakin *et al*. 2012). Color is an important quality factor directly related to the acceptability of food products, and is an important physical property to report. Bulk density is a measure of heaviness of flour and is generally affected by the particle size and the density of the flour (Gull *et al*. 2002). Okezie and Kosikowski (1981) reported that Wettability is the time required by flour to reach its wetness. Wettability is important in reconstitution in water; it is related to the presence of soluble molecules, and lower wettability indicates better reconstitution properties (Colona *et al*. 1989).

Malted finger millet is used like *ragi malt puff, bhakri, bread* and *cookies*, it is necessary to know the information about the physico-chemical properties of finger millet flour and finger millet malt flour. Considering all the points discussed as above, the present study had been undertakes with the objective to study the physico-chemical properties of finger millet flour and the finger millet malt flour.

MATERIALS AND METHODS

Development of Finger Millet malt:

The finger millet malt was prepared as per the procedure described by Swami *et al.* (2013). Finger millet grain of *Dapoli-1* variety was brought from the local market. The grain were cleaned and made it free from dirt, dust and small stones. 1000 g of clean finger millet grains were soaked in the tap water 1:3 for 5h at normal atmospheric temperature (31± 1°C). The water was drained out and the soaked grains were placed in a muslin cloth and allowed to germinate for 24 hours. The germinated sample was removed from moist cloth after 24 h for germination and placed in a tray dryer at 45°C. The moisture content w. r. t time was recorded at every 10 minutes interval. The drying continued till the constant weight was observed which was recorded with the five constant weight readings. After the drying was complete the vegetative growth portion were removed by gentle brushing by hand. The devegetative seeds were grounded to the flour by using the food processor (M/s: Aditi Associates Mumbai; Model: ATD-124; having power require 5 kW).

Moisture content

The initial moisture content of the finger millet seeds and devegetative seeds separately was determined by AOAC, 2000. 5 g sample was taken in three moisture boxes and these were kept in the hot air oven at 110°C for 24 hours. The weight of sample was measured before and after exposition to the oven was determined by using equation (1).

$$\text{Moisture content (\% db)} = \frac{W_2 - W_1}{W_3 - W_1} \times 100 \qquad \ldots (1)$$

Where,

W_1 = Weight of moisture box, g

W_2 = Weight of moisture box + sample g

W_3 = Weight of moisture box + oven dried sample, g

The moisture content *w. r. t* time and drying rate *w. r. t* moisture content was determined for the finger millet malt.

2.3 Finger millet flour

The finger millet grain of *Dapoli 1* variety before and after malting was determined as per equation (1) was grounded in the food processor (earlier specified) to convert it into flour. The property of finger millet malt and finger millet flour was studied.

Drying characteristics

Moisture content (% db) versus drying time (min) and drying rate (g of water removed /100 g of bone dry material/min) with respect to the moisture content was determined for tray drying of Finger millet.

1. Drying rate

The drying rate of finger millet malt was calculated on dry basis using following equation (2) (Chakraverty, 1994).

$$R = \frac{W_r}{T \times Wd} \times 100 \qquad \ldots (1)$$

Where,

R = Drying rate (g/min)

W_r = Amount of moisture removed (g)

T = Time taken (min)

W_D = Total bone dry weight of sample (g)

Physico-chemical properties of Finger millet flour and Finger millet malt

1. Moisture content

The initial moisture content of finger millet malt and finger millet seed flour were determined by using hot

air oven method (AOAC, 2000). As per the procedure explained in 2.2.

2. Protein

Crude protein of the finger millet malt and finger millet seed flour was determined using the Kjedahl method according to AOAC (1990). One gram of the finger millet malt and finger millet seed flour was taken into the digestion flask. Kjedahl catalyst (Selenium tablets) was added to the sample. Twenty milliliter of concentrated sulphuric acid was added to the sample and fixed to the digester flask for eight hours until a clear solution was obtained. The cooled digester mass was transferred into one hundred mils volumetric flask and made up to the mark with distilled water. The distillation apparatus was set and rinsed for ten minutes after boiling. Twenty milliliter of 4% boric acid was pipetted into conical flask. Five drops of methyl red was added to the flask as indicator and the sample was diluted with seventy five milliliter distilled water. Ten milliliter of the digest was made alkaline with twenty miles of NaOH (20%) and distilled. The steam exit of the distillatory was closed and the change of color of boric acid solution to green was timed. The mixture was distilled for fifteen minutes. The filtrate was then titrated against 0.1 N HCL. % Nitrogen of the sample was calculated from equation (3) and % protein was calculated from equation (4)

$$\% N = \frac{\text{(Sample titre – Blank titre)} \times \text{N HCL} \times 1.4 \times 100}{\text{Weight of sample}} \times 100 \quad \ldots (3)$$

$$\% \text{ protein} = \% \text{ nitrogen} \times \text{conversion factor (6.25)} \quad \ldots (4)$$

3. Fat

Fat content of finger millet malt and finger millet seed flour were determined by soxhlet fat extraction system (AOAC, 2010) by Soxhlet apparatus (Make: Elico, Hyderabad). In this method, initially weight of empty flask was weighted. 2 g malt and finger millet flour were wrapped separately in filter paper. The malt and flour sample with filter paper was kept in siphoning tube and condenser was fixed above it and siphoned for 9-12 times with the petroleum ether in soxhlet apparatus. After removing assembly, evaporation of petroleum ether was allowed by heating round bottom flask. Residue remained at the bottom of the flask and was reweighted with flask. The quantity of residue was determined as fat content of malt and flour. The experiment was replicated for 3 times. The average value of fat content is reported. The fat content was calculated by using following equation (5);

$$\% \textit{ Fat content} = \frac{\text{Final wt.} - \text{Initial wt.}}{\text{Wt. of sample}} \times 100 \quad \ldots (5)$$

4. Ash

Ash content in Aloe vera powder was determined as described by Ash content of malt and finger millet seed flour was determined by using muffle furnace. 5 g of malt and flour sample was taken in a crucible. Weight of crucible and flour was recorded kept in muffle furnace at 650°C for 4-5 h till constant weight was achieved. It was observed for their constant readings. The crucible was cooled in desiccators and final weight of ash and crucible was recorded. The experiment was replicated for 3 times. The average value of ash content was reported. The ash content was calculated by using following equation (6);

$$Ash = \frac{W_2 - W}{W_1 - W} \times 100 \quad \ldots (6)$$

Where,

W = weight of crucible, g;

W_1 = weight of crucible and flour, g; and

W_2 = weight of crucible with ash, g

5. Crude fiber

The fiber content malt and finger millet seed flour was determined by the fat free sample available in filter paper from fat extraction method (Ranganna, 1986). The filter paper and fat free residue was kept in the oven for 105 C for 5-6 hours. Around 2 g sample from oven was taken into 600 ml beaker and boiled, 200 ml

1.25 % H_2SO_4 was added to it. The beaker containing solution was placed on hot plate for 30 min. After heating residue from beaker was filtered through filter paper and rinsed beaker with 50 to 75 ml boiling water for three times. The filtered residue from filter paper was dried by convective hot air drying for 2-3 h at 130˚C. The dried residue from convective hot air dryer was transferred to 600 ml beaker and boiled, 200 ml 1.25 % NaOH was added to it and boiled for 30 more minutes on hot plate. After heating residue from beaker was filtered through filter paper and rinsed beaker with 50 to 75 ml boiling water for three times. The filtered residue from filter paper was dried by convective hot air drying at 130˚C for 2h. The dried residue was weighted after cooling and weight was noted. The weighed residue was transferred to crucible in hot air oven and ignited for 30 minutes at 600˚C and reweighed after cooled in dessicator and weight was recorded. The experiment was replicated for 3 times. The average value of crude fiber content was reported. The crude fiber content was calculated by using following equation (7);

$$\% \, Fiber = \frac{\text{Weight of residue with crucible} - \text{Weight of ash with crucible}}{\text{Weight of sample}} \times 100 \quad \ldots (7)$$

6. Carbohydrates

Carbohydrate content of the finger millet malt and finger millet seed flour samples was determined by subtracting the total sum of protein, fiber, ash and fat from the total dry matter (James, 1995). The carbohydrate was calculated by using following equation (8)

$$\% \text{ Carbohydrate} = 100 - (\% \text{ protein} + \% \text{ fat} + \% \text{ fiber} + \% \text{ ash} + \% \text{ moisture content}) \quad \ldots (8)$$

7. Bulk density

The bulk density of malt and finger millet seed flour was determined according to the method described by (Vengaiah *et al.* 2013). A graduated measuring cylinder of 5 ml was weighed and finger millet malt and flour sample filled in to it by constant tapping until there was no further change in volume. The cylinder with the malt and flour sample was weighed and the difference in weight was determined. The experiment was replicated for 3 times the average value of bulk density was reported. The bulk density was calculated by using following equation (9);

$$Bulk\ density = \frac{W_2 - W_1}{\text{Volume of sample}} \times 100 \quad \ldots (9)$$

8. Water absorption capacity

The water absorption capacity of malt and finger millet seed flour was determined by the method of Chandra and Samsher, 2013. 1g of malt and finger millet flour sample was mixed with 10 ml distilled water in centrifuge tube and allow to stand at ambient temperature (30˚C) for 1h, the mixture was centrifuged by using centrifuge (Make: M/s Remi Electrotecnik limited, Thane, India; Model: R-8C BL) for 30 min at 2000 rpm. The sediments were weighed after complete removal of the supernatant. The experiment was replicated for 3 times. The average value of water absorption capacity was reported. The water absorption capacity was calculated by using following equation (10);

$$WAC = \frac{(W_2 - W_1)}{W_0} \times 100 \quad \ldots (10)$$

Where,

W_0 = the weight of the sample, *g*;

W_1 = the weight of centrifuge tube plus sample, *g* and

W_2 = the weight of centrifuge tube plus the sediments.

9. Wettability

Wettability of the finger millet flour and malt was determined with an (Atomizer, 1978). 100 ml of distilled water (at 21˚C) was poured into a beaker. A flour and malt sample (10g) was placed around the pestle (inside the funnel so that it blocked the lower opening). The pestle was lifted and the stopwatch was started at the same time. Finally, time was recorded when the flour and malt became completely wetted

(visually assessed as the time when all the flour and malt particles penetrated the surface of the water.

10. Colour

Colour of finger millet malt and finger millet seed flour was measured by using Konica Minolta colour Reader. (Make: Minolta Camera Co. Ltd. Japan Model: (R-10). The colour of the Samples was measured in dark room. The malt and flour samples of finger millet was placed on white surface and placing colour reader on the flour sample in a Petri dish and the colour was measured in *L*, *a*, *b* were reported. Where *L* value indicates degree of lightness or darkness, '*a*' value indicates redness or greenness and '*b*' value indicates the yellowness or blueness.

Statistical Analysis

The data for various physico-chemical properties of finger millet malt and flour was analyzed by ANOVA and the statistical significance was tested using Microsoft Excel 2007 software on it at $p \leq 0.01$.

RESULTS AND DISCUSSION

Drying Characteristics

Fig. 1 shows moisture content (db) % with respect to time (min) of finger millet germinated vegetative seeds dried by tray drying. The germinated finger millet seed was dried from an average initial moisture content of 40.409% (db) to 5.155 ±2% (db). It took around 6 h for drying of finger millet malt by tray drying at 45^{0}C to complete the drying process.

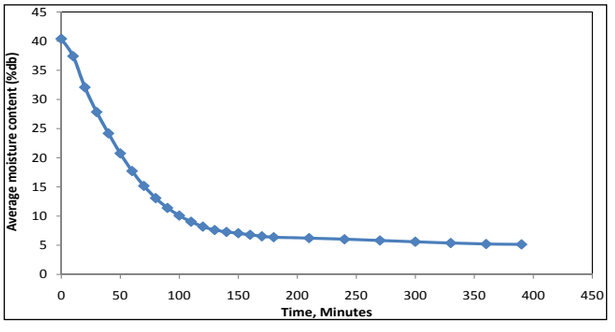

Fig. 1: Average Moisture content (% db) versus Time (Min) of Finger millet germinated vegetative seed dried by hot air drying at 45°C

Fig. 2 shows the drying rate (g water removed/100g dry bone dry material/min) with respect to moisture content % (db) of germinated finger millet dried by tray drying. The drying rate decreases from 0.350 to 1.169×10^{-3} g water removed/100g dry solid/min.

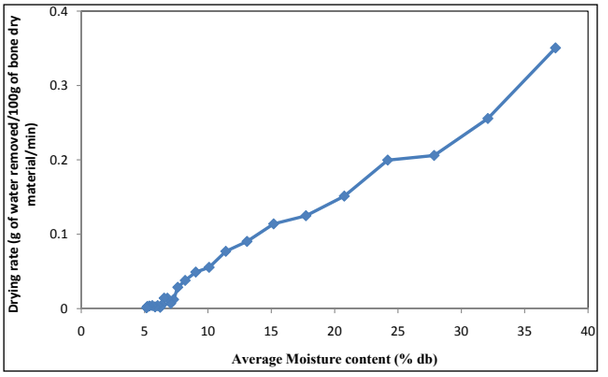

Fig. 2: Drying rate (g of water removed /100g of bone dry material/min.) versus Average moisture content (%db) of finger millet germinated seeds dried by convective hot air drying method

Fig. 3 shows the moisture ratio versus time of germinated finger millet grain at 45°C. The moisture ratio decreases from 1.0 to 5.73×10^{-6}.

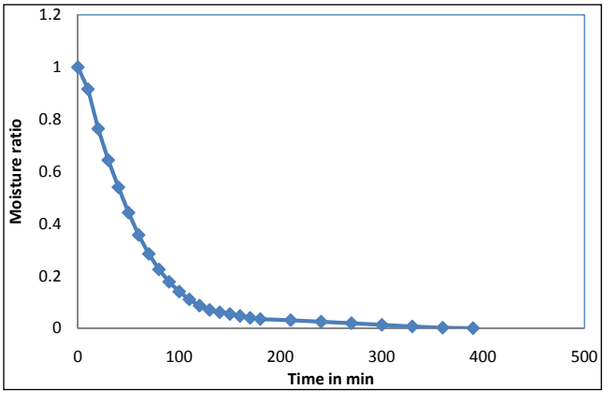

Fig. 3: Moisture ratio versus Time in minutes for Finger millet malt dried by convective hot air dryer at 45°C temperature

Fig. 4 shows graph of Ln (MR) versus time, min. Linear equation obtained from the graph i.e. $y = -0.020x + 0.232$ was compared to standard equation i.e., $y = mx+c$. m value indicates the slope of line. From the slope the diffusivity value was calculate.

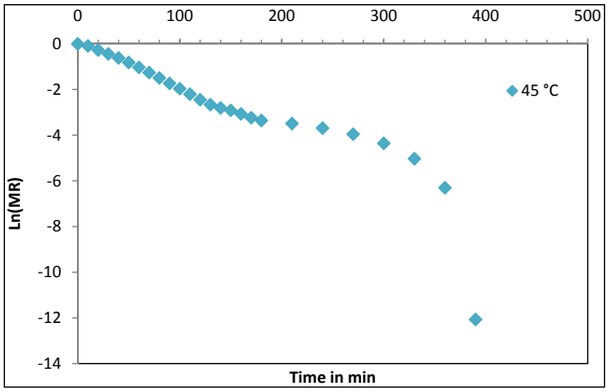

Fig. 4: Ln (MR) Versus Time in minute for effective diffusivity of finger millet malt

Physico-chemical and functional properties of Finger millet malt and Finger millet flour

Table 1 shows the physico-chemical and functional properties i.e. Moisture content %, protein %, Ash %, fiber %, carbohydrates %, bulk Density (g/cc), water absorption capacity, wettability of finger millet malt and finger millet seed flour. The stastical analysis in terms of SE and CD (P≤0.01) is also gives in the table.

1. Moisture

Table 1(a) shows the moisture content for finger millet malt and finger millet flour. Moisture content varied for finger millet malt was 5.6±0.10 per cent and finger millet flour was 5.4±0.01 per cent. Highest moisture content observes in finger millet malt (5.6±0.10) as compare with finger millet flour (5.4±0.01). The decrease of moisture content was significant at p≤0.01. James *et al.* (2015) noticed that 4.26±2.00 per cent moisture in millet flour.

2. Protein

Table 1(b) shows the protein content for finger millet malt and finger millet flour. Protein content varied for finger millet malt was 6.43±0.26 per cent and finger millet flour was 6.16±0.04 per cent. Highest protein content observes in finger millet malt (6.43±0.26) as compare with finger millet flour (6.16±0.04). The malting had an increased effect on the protein content of finger millet flour. This increase in crude protein content during malting could be because of synthesis of enzyme proteins or a compositional change following the degradation of other constituents during germination (Bau *et al*. 1997). The increase in protein was significant at p≤0.01. The identical result was reported by Lande *et al.* (2017) who recorded 6.33, 6.42 per cent protein content in finger millet flour and finger millet malt respectively. Prakash and Chopra, (2016) reported that protein content in finger millet flour and finger millet malt was 7.30±0.18 and 7.83±0.14 per cent respectively.

3. Fat

Table 1 (c) shows the fat content for finger millet malt and finger millet flour. Fat content varied for malt was 1.18±0.05 per cent and finger millet flour was 1.07±0.03 per cent. The increase of fat content was significant at p≤0.01. Similar results was observed by Lande *et al.* (2017) who reported that the fat content of finger millet flour and malt was 1.08, 1.14 per cent respectively. A similar result was observed by Prakash and Chopra, (2016) who reported that the fat content in finger millet flour and finger millet malt was 1.07±0.05, 1.15±0.14 per cent respectively.

4. Ash

Table 1(d) shows the ash content for finger millet malt and finger millet flour. Ash content varied for finger millet malt was 1.5±0.03 per cent and finger millet flour was 1.15±0.06 per cent. Highest ash content observes in finger millet malt (1.5±0.03) than finger millet flour (1.15±0.06). The increase of ash content was significant at p≤0.01. Similar results was observed by Lande *et al.* (2017) who reported that the ash content of finger millet flour and malt was 1.91, 1.96 per cent respectively. James *et al.* (2015) noticed that 1.07±2.00 per cent ash in millet flour. Similar results was observed by Prakash and Chopra, (2016) who reported that the ash content in finger millet flour and finger millet malt was 1.48±0.20, 1.88±0.16 per cent respectively. Nischal and Dev Raj, (2015) reported that ash content in unmalted and malted sorghum flour was 0.56±0.02 and 2.1±0.04 per cent respectively. Charles *et al.* (2016) reported that ash

content in whole sorghum and malted sorghum flour ranged was 1.65 ±0.03 to 1.32± 0.16 per cent respectively.

5. Fiber

The Table 1(e) shows the fiber content for finger millet malt and finger millet flour. Fiber content varied for finger millet malt was 3.75±0.01 per cent and finger millet flour was 3.1±0.30 per cent. Highest fiber observes in finger millet malt (3.75±0.01) as compare with finger millet flour (3.1±0.30). The increase of fiber content was significant at p≤0.01. Similar results was observed by Lande *et al.* (2017) that the fiber content of finger millet flour and malt was 3.15, 3.36 per cent respectively. A similar result was observed by Prakash and Chopra, (2016) that the fiber content in finger millet flour and finger millet malt was 3.21±0.05, 3.91±0.06 per cent respectively. Nischal and Dev Raj, (2015) reported that fiber content in unmalted sorghum flour and malted sorghum flour ranged was 2±036 per cent, 3.45±0.101 per cent. Gull *et al.* (2002) reported that fiber content in finger millet flour and pearl millet flour ranged was 3.03±0.05 to 3.05±0.05 per cent. Changes in fiber content may be attributed to the fact that part of the seed fiber may be solubilized enymatically during seed germination. Maki *et al*. (1999).

6. Carbohydrate

The data with respect to the carbohydrate of finger millet malt and flour presented in Table 1 (f). Carbohydrate content varied for finger millet malt was 81.57±0.42 per cent and finger millet flour was 83.12±0.28 per cent. Highest carbohydrate observes in finger millet flour (83.12±0.28) as compare with finger millet malt (81.57±0.42). The decrease in carbohydrate was significant at p≤0.01. Carbohydrates are less in finger millet malt as compare to finger millet flour, because the malting had a slightly increasing effect on the protein, fiber, fat.

7. Bulk density

Table 1(g) shows the bulk density for finger millet malt and finger millet flour. Bulk density content varied for finger millet malt was 0.606/cc g and finger millet flour was 0.588/cc g. Highest bulk density observes in finger millet malt (0.606 g/ml) as compare with finger millet flour (0.588 g/ml). The bulk density was significant at p≤0.01. Gull *et al.* (2002) reported that the bulk density of pearl millet and finger millet flours ranged from 0.67g/ml to 0.54g/ml. Krishnan *et al.* (2011) observed the bulk density was 0.5g/ml, 0.50g/ml and 0.6g/ml in native, malted and hydrothermally treated finger millet seed coat.

8. Water absorption capacity

Table 1(h) shows the water absorption capacity content for finger millet malt and finger millet flour. Water absorption capacity for finger millet malt was 2.94±0.02 g/ml and finger millet flour was 2.08±0.14 g/g, highest water absorption capacity observed in finger millet malt (2.94±0.02 g/g) as compare with finger millet flour (2.08±0.14 g/g). The increase of water absorption capacity content was significant at p≤0.01. Nwosu *et al*. (2010) reported that water absorption capacity of unmalted sample had the lowest value of water absorption capacity 1.78 per cent than malted sample had the highest water absorption capacity of 1.98 per cent.

9. Wetability

Table 1 (i) shows the wetability for finger millet malt and finger millet flour. Wetability varied for finger millet malt was 41±1.00 (sec) and finger millet flour was 40±1.00 (sec). Wetability was significant at p≤0.01. Nwosu *et al*. (2010) reported that the 24 hours soaked asparagus flour and malted for 72 hours have the least wettability 42 sec.

10. Colour

Table 1 (j) shows the colour for finger millet malt and finger millet flour. L value for finger millet malt was 88.55±0.33 and after drying of finger millet malt flour L value was 88.31±0.51, a value for finger millet malt was 4.12 ±0.0 and after drying of finger millet malt flour a value was 3.51 ±0.03 and b value for finger millet malt was 9.05 ±0.01 and after drying of finger millet malt flour b value was 9.01 ±0.05.

Table 1: Physico-chemical and functional propeteis of finger millet malt and finger millet

Treatments	(a) Moisture content (% db)	(b) Protein (%)	(c) Ash (%)	(d) Fiber (%)	(e) Fat (%)	(f) Carbohydrate (%)	(g) Bulk density (g/cc)	(h) Water absorption capacity (g/ml)	(i) Wetability (sec)	(j) Colour		
										L	a	b
Finger millet malt	5.6±0.10	6.43±0.26	1.5±0.03	3.75±0.01	1.18±0.05	81.57±0.42	0.606±0.0	2.94±0.02	41±1.00	88.55±0.33	4.12±0.0	9.05±0.01
Finger millet	5.4±0.01	6.16±0.04	1.15±0.06	3.1±0.30	1.07±0.03	83.12±0.28	0.588±0.0	2.08±0.14	39±1.00	88.31±0.51	3.21±0.03	9.01±0.05
SEm ±	0.04	0.11	0.02	0.12	0.02	0.20	0.0	0.06	0.58	0.25	0.01	0.02
CD $_{\text{at 1\%}}$	0.25	0.69	0.16	0.78	0.16	1.33	0.01	0.36	3.76	1.63	0.08	0.14

CONCLUSION

The present work describes the comparison of finger millet malt and seed four w. r. t. various physico-chemical and functional properties i.e. moisture content, protein, ash, fiber, fat, carbohydrates, bulk density, water absorption capacity and wettability. The moisture content 5.6±0.10, protein 6.43±0.26, ash 1.5±0.03, fiber 3.75±0.01, fat 1.18±0.05, carbohydrates 81.57±0.42, bulk density 0.606±0.0, water absorption capacity 2.94±0.02 and wettability 41±1.00 was present in the malted finger millet flour. The malted flour can be used for the better functional and physico-chemical properties in cookies.

REFERENCES

Alasalvar, C.F. Shahidi (Eds.) 2013. Dried Fruits: Phytochemicals and Health Effects. Experimental Methods. In: Analytical Chemistry of Foods, Champman and Hall, New York, 28.

AOAC, 2010. Official Methods of Analysis. 18th Edition. Association of Official Analytical Chemists.

Chandra, S. and Samsher. 2013. Assessment of functional properties of different flours. *African Journal of Agricultural Research*, **8**(38): 4849-4852.

Charles, B., Evaristus, O.C, Mamudu, H.B. and Ladi, H.K. 2016. Production of powdered maize Ogi (indigenous complementary food) flours complemented with soybean and sorghum malt. *MAYFEB Journal of Agricultural Science,* **3**: 1-14.

Chetan, S. and Malleshi, N.G. 2007. Finger millet polyphenols: Characterization and their nutraceutical potential. *Am. Journal of Food Technology*, **2**(7): 582-592.

Devi, P.B., Vijayabharathi, R., Satyabama, S., Malleshi, N.G. and Prayadarisini, V.B. 2014. Health Benefits of finger millet (*Eleusine coracana* L.) poyphenols and dietary fiber: a review. *J. Food Sci. Tech.*, **51**(6): 1021-1040.

Dida, M.M., Wanyera, N., Dunn, M.L.H., Bennetzen, J.L. and Devas, K.M. 2008. Population structure and diversity in finger millet (*Eleusine coracana*) germplasm, *Trop. Plant. Biol.*, **1**(2): 131-141.

Enej, L.O., Ogu, E.O. and Palmer, G.H. 2003. Effect of steeping and germination time on malting performance of Nigerian white and yellow maize varieties process. *Biochemistry*, **39**(8): 1013-1016.

FAO. 2013. http://faostat.fao.org/site/339/default.aspx.

Gao, Q.H., Wu, C.S., Wang, M., Xu, B.N. and Du, L.J. 2012. Effect of drying of Jujubes (*Ziziphus jujuba* Mill.) on the contents of sugars, organic acids, a-tocopherol, bcarotene, and phenolic compounds, *J. Agric. Food Chem.*, **60**: 9642–9648.

Gull, A., Kamlesh, P. and Kumar, P. 2002. Physico-chemical, Functional and Antioxidant Properties of Millet Flours. Conceptual Frame Work and Innovations in Agroecology and Food Sciences, ISBN: 978-81-930585-1-0.

James, S., Oloyede, O.O., Ocheme, O.B., Chinma, C.E. and Agbejule, A.Y. 2015. Proximate, anti-nutrient and sensory properties of ogi, a millet based gruel supplemented with treated African oil bean (*Pentaclethra macrophylla Benth.*) seed flour. *African Journal of Food Science*, **9**(3): 136-141.

Krishnan, R., Dharmaraj, U., Manohar, S.R. and Malleshi, N.G. 2011. Quality characteristics of biscuits prepared from finger millet seed coat based composite flour, *Journal of Food Chemistry*, **129**: 499-506.

Lande, S.B., Thorats, S. and Kulthe, A.A. 2017. Production of Nutrient Rich Vermicelli with Malted Finger Millet (Ragi) Flour. *Int. J. Curr. Microbiol. App. Sci.*, **6**(4): 702-710.

Majumdar, A.S. and Law, C.L. 2010. Drying Technology: Trends and application. *Food Bioprocess Technology*, **3**: 843-852.

Mc Keown, N.M., Meigs, J.B., Liu, S., Wilson, P.W. and Jacqucs, P.F. 2002. Whole grain intake is favourably associated with metabolic risk factors for type 2 diabetes and Cardiovascular disease in the framinkam offspring study, *Am. J. Clin. Nutrition*, **76**(2): 390-398.

Michalska, A., Honke, J., Łysiak, G. and Andlauer, W. 2016. Effect of drying parameters on the formation of early and intermediate stage products of the Maillard reaction in different plum (*Prunus domestica* L.) cultivars, *LWT - Food Sci. Technol.*, **65**: 932–938.

Nielsen, S.S. 2009. Food Analysis, 4th Ed. Springer New York Dordrecht Heidelberg London, pp. 48-55.

Nischal, A. and Acharya, D.R. 2015. Effect of incorporation of malted sorghum flour on quality of biscuit. *Sunsari Technical College Journal*, **2**(1): 33-37.

Nwosu, J.N., Ogueke, C.C., Owuamanam, C.I. and Iwouno, J.O. 2010. Functional Properties and Proximate Composition of Asparagus Bean (*Vigna sesquipedalis*) as Influenced by Malting. *Journal of American Science*, **6**(9).

Ogunlakin, G.O., Oke, G.O. Babarinde and Olatunbosun, D.G. (2012). Effect of drying methods on proximate composition and physico-chemical properties of cocoyam flour. *American Journal of Food Technology*, **7**(4): 245-250.

Prakash, K. and Chopra, R. 2016. Enhancement of nutritional and sensorial attributes of murukkus by accompaniment of malted finger millet (*Eleusine coracana*). *Asian Journal of Science and Technology*, **07**: 3038-3043.

Scalbert, A., Manach, C., Morand, C., Remesy, C. and Jimenz, L. 2005. Dietary polyphenols and prevention of diseases. *Critical Reviews in Food Sci. and Nutrition*, **45**(4): 287-306.

Swami, S.B., Thakor, N.J. and Shinde, U.N. 2013. Effect of Baking Temperature and Oil Content on Quality of Finger Millet Flour Cookies. *Journal of Agricultural Engineering*, **50**(4).

Tian, Y., Zhao, Y., Huang, J., Zeng, H. and Zheng, B. 2016. Effects of different drying methods on the product quality and volatile compounds of whole shiitake mushrooms, *Food Chem.*, **197**: 714–722.

Upadhyalya, H.D., Gowda, C.L.L. and Ready, V.G. 2007. Morphological diversity in finger millet germplasm introduced from Southern and Eastern Africa, *J.SAT. Agric. Res.*, **3**(1): 1-3.

Vengaiah, P.C. 2013. Physico-chemical and functional characteristics of palmyrah (*Borassus flabellifer* L) tuber flour. *Journal of Plantation Crops*, **41**(3): 437-440.