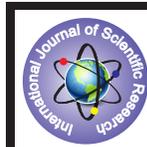


Changes in Nutritional Quality of Traditional Fermented Food Made from Pearl Millet



Agriculture

KEYWORDS : Pearl millet, fermentation, phytic acid, minerals

P. Suganya

Asst Professor, Dept of Food Processing and Preservation Technology, Faculty of Engineering, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641108

Dr. R. Kailappan

Professor, Dept of Food and Agricultural Process Engineering, AEC&RI, TNAU, Coimbatore -641003

ABSTRACT

The dehusked pearl millet of three different sizes ranging from 1.7 to 1.4, 0.79 to 0.50 and less than 0.5 mm were mixed at 1:1:1 ratio (RTC mix). This mixture was cooked with optimized quantity of water and salt. The food prepared was mixed with boiled and cooled milk and inoculated with 10ml quantity of curd culture. The mixture was allowed to ferment at a temperature of 40 - 43°C. As fermentation time increased, protein, fat and calcium content increased from 8.2 to 8.8, 6.3 to 8.8 % and 113.7 to 202 mg/100g, respectively and carbohydrate and iron content decreased from 71.5 to 50 % and 58.7 to 34 mg/100g, respectively. The phytic acid (anti nutritional factor) content decreased from 303 to 200 mg/100g within 4h, which showed that the fermentation process enhance the conversion of phytic acid to available phosphorus.

Introduction

Pearl millet (*Pennisetum typhoides*) is family of gramineae originated in Africa and was subsequently introduced to India (Khairwal *et al.*, 1990). Pearl millet has long been considered to be a crop of secondary importance. It is now the fourth most important cereal in terms of area cultivated (after rice, wheat and sorghum). It is a stable food for Asian and African countries and contributes a major part of dietary nutrients. Its traditional role in the life of the people is reflected in its use in traditional dishes and its inclusion in religious rites, traditional and kinship patterns. Some of the important key foods prepared from pearl millet in various countries include leavened bread (kiswa, injera), unleavened flat bread (roti), stiff porridge (kanji) thin porridge (Kool), snack (fura) beer (buss, pito) and non alcoholic beverages. According to FAO, 1995 nearly 38 % of the pearl millet consumers throughout the world including India, consume pearl millet in the form of a stiff porridge made out of mixture of coarse particles and fine powder of pearl millet.

Pearl millet grain contains 11.8% protein, 2.3% crude fibre, 67% carbohydrates, 2.2% ash, 42 mg of Calcium, 11 mg of Iron, 0.38 mg of Thiamin, 0.21 mg of Riboflavin and 2.8 mg of Niacin (Hulse. *et al.*, 1980) and it has a greater oil content (4 - 9%) than all other cereal crops (Desikachar, 1975). Though the nutritive value is huge it has long been considered to be a crop of secondary importance due to lack of technical knowledge of processing methods, lack of awareness among people about nutritive value and is coined as poor men crop, the non-availability of processed products similar to rice or wheat are the main reasons for less popularity of pearl millet among rice and wheat eaters. Phytic acid content in pearl millet represents more than 70% of the total phosphorus of the grain (Abdel Rahman *et al.*, 2007). A value of 990 mg/100 g phytic acid was reported by Khetarpaul and Chauhan (1990), while Kumar and Chauhan (2006) gave a value of 825.7 mg/100 g. Abdel Rahman *et al.* (2007) reported that millet contains some antinutrients (phytate and polyphenols) that affect nutrient absorption by the human body. The food industry has become increasingly interested in novel food processing technologies which promise to preserve and improve the quality of food without the use of heat or chemical additives while still retaining the food quality such as refrigeration and irradiation (Mohamed *et al.*, 2010). In the present work was undertaken to explore the effects of fermentation on anti-nutrients and nutrients of raw and processed dehulled pearl millet flour.

2. Materials and Method

2.1 Collection and sample preparation

Dehusked, cleaned pearl millet was procured from the local market and made in to broken using RTC mix processor designed by Tamil Nadu Agricultural University, Coimbatore. RTC mix processor consists of burr mill, conveying chute and three

sieves with different clearings to obtain various size of broken. Larger broken of 1.70 to 0.80 and 1.4 to 0.71mm, smaller broken of 0.79 to 0.50 and 0.70 to 0.425mm and coarse of size between < 0.5 and < 0.425mm in 1:1:1 ratio were used to prepare food. 250 ml of water and 5g of salt was added to 100g of RTC mix and stirred well and pressure cooked and cooled to 45°C. 225ml of milk and 10ml of culture was added to the cooked mix along with chopped onion, cut curry leaves and spices. This mix was allowed to ferment for 4h at 40 - 43°C.

2.2 Determination of moisture content

The moisture content was determined by using a hot air oven as per the procedures outlined by Association of Official Analytical Chemists (AOAC,1995). The temperature was maintained at 105°C. The sample were dried for 1 h till they reached bone dry condition.

The moisture content was calculated using the formula

$$MC, \% (d.b) = \frac{W_w}{W_d} \times 100$$

where,

MC, % (d.b) - moisture content, per cent (dry basis).
 W_w - weight of water evaporated to reach bone-dry condition, g.
 W_d - weight of dry matter content present, g.

2.3 Determination of pH

The pH of the fermented dough was monitored initially and every 1h using a glass electrode pH meter.

2.4 Determination of protein

Protein (N×6.25) was determined by the Kjeldahl method. All nitrogen is converted to ammonia by digestion with a mixture of concentrated sulfuric acid and concentrated orthophosphoric acid containing copper sulfate and potassium sulfate as a catalyst. The ammonia released after alkalization with sodium hydroxide is steam distilled into boric acid and titrated with hydrochloric acid.

2.5 Determination of fat

Crude fat was determined by exhaustively extracting a known weight of sample in diethyl ether (boiling point, 55°C) in a Soxhlet extractor. The ether was evaporated from the extraction flask. The amount of fat was quantified gravimetrically and calculated from the difference in weight of the extraction flask before and after extraction as percentage.

2.6 Determination of Mineral

The mineral contents were determined by the procedure of AOAC (1984). Calcium and iron were determined using an

Atomic Absorption Spectrophotometer. After removal of organic material by dry ashing, the residue was dissolved in dilute acid. The solution was sprayed into the flame of Atomic Absorption Spectrophotometer and the absorption of the metal to be analyzed was measured at a specific wavelength.

Standard solutions: The stock standard solutions of minerals (iron and calcium) were diluted with 0.3 N HCl to concentrations that fall within the working range 0.0, 1.0, 1.5, 2.0, and 3.0 µg/ml for calcium analysis and 0, 2.0, 6.0, 10.0 12.0 µg/ml for iron analysis). The Atomic Absorption Spectrophotometer (AAS) used for mineral determination were calibrated using standard solutions and the reagent blank solution was run with the sample.

2.7 Determination of phytate (Anti nutritional factor)

Phytate was determined by the method of Latta and Eskin (1980) and later modified by Vantraub and Lapteva (1988). About 0.1000g of fresh samples were extracted with 10ml 2.4% HCl in a mechanical shaker (Eberbach) for 1hour at an ambient temperature and centrifuged at 3000rpm for 30 minute. The clear supernatant was used for phytate estimation. A 2 ml of Wade reagent (containing 0.03 % solution of FeCl₃·6H₂O and 0.3% of sulfosalicylic acid in water) was added to 3 ml of the sample solution (supernatant) and the mixture was mixed on a Vortex (Maxi Maxi II) for 5 seconds. The absorbance of the sample solutions were measured at 500 nm using UVVIS spectrophotometer.

$$\text{Phytic acid in } \frac{\text{mg}}{100\text{g}} = \frac{(\text{absorbance} - \text{intercept})3}{\text{slope} \times \rho \times \text{wt. of sample} \times 10}$$

Where, ρ is density

Moisture content, carbohydrates, protein, fat, calcium, iron and phytic acid content were determined at 1-h intervals as triplicate and Agress software was used for statistical analysis.

3. Results and Discussion

3.1 Effect of processing and fermentation on moisture content of RTC pearl millet mix

Moisture content determination is an integral part of the proximate composition analysis of food. The moisture content of raw pearl millet RTC mix is 10% (w.b) and slightly increased during cooking due to addition of water. The fermentation process indicated that the moisture content is significantly increased from 20.2 and 30.3 % (w.b) when the fermentation time increases (Fig.1).

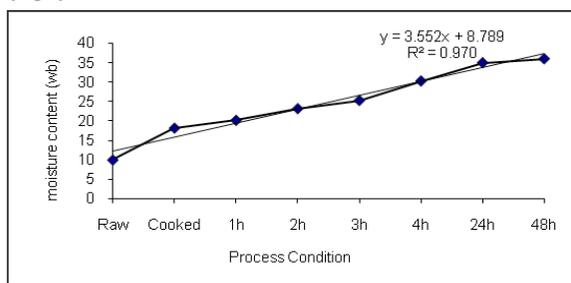


Fig.1. Changes in moisture content of RTC mix at different processing condition

3.2 Effect of fermentation on pH of RTC pearl millet mix

Fig 2. Indicates the decrease in pH for increased fermentation time. The pH drop was probably the result of microbial activity on RTC pearl millet mix converting some of the carbohydrates in to organic acids such as lactic acid and other volatile short chain fatty acids. A decrease in pH has been reported in fermentation of various food grains (Abdel haleem *et al.*, 2008; Shimelis and Rakshit, 2008). According to these authors, the production of lactic acid bacteria during fermentation has attributed to the decrease in pH. In traditionally fermented products, the drop in pH and an increase in acidity were a means for protection from many food pathogens (Shimelis and Rakshit, 2008).

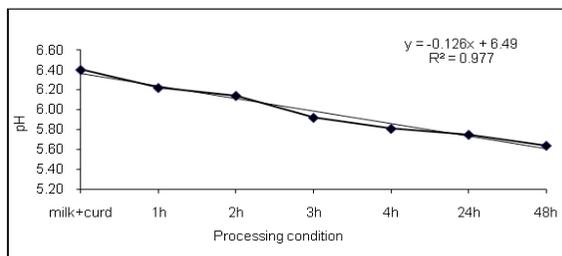


Fig.2. Changes in pH of RTC mix at different fermentation time

3.3 Effect of processing and fermentation on carbohydrates, Protein and fat of RTC pearl millet mix

Fig 3. clearly indicates that decrease in carbohydrate content with increase in fermentation time. This is due to microbial activity on Pearl millet mix. The available carbohydrates are converted to organic acids due to fermentation process and significantly reduced the amount of carbohydrates which may be described to utilization of sugars by the fermenting microflora.

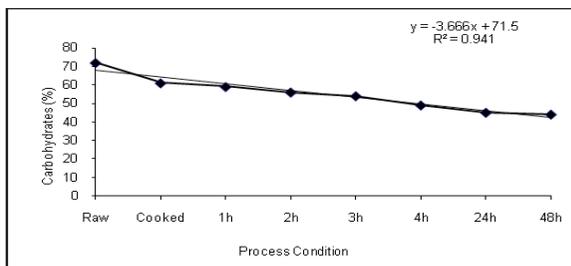


Fig. 3. Changes in carbohydrates of RTC mix at different processing condition

The addition of milk and curd culture increased the protein and fat content at the initial stage of fermentation (Fig. 4 and Fig. 5). The further fermentation process slightly decreases the protein content of pearl millet RTC mix. A negligible decrease in fat content is observed. This results are in agreement with the Khetarpaul and Chauhan, 1989 for fermented pearl millet flour.

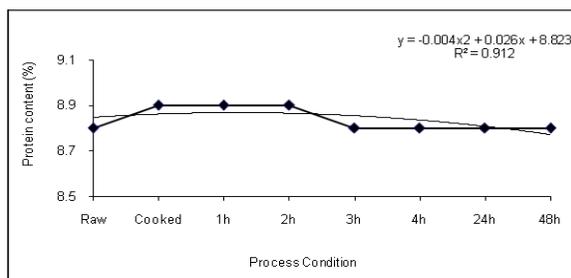


Fig.4. Changes in protein content of RTC mix at different processing condition

3.4 Effect of processing and fermentation on Calcium and iron of RTC pearl millet mix

Fig. 7 clearly shows that the decrease in iron content from 58.7 to 34 mg/100g after cooking and there is no significant changes during fermentation process. This reduction could be attributed due to the minerals leached from the RTC mix in to the water during cooking process. Gradual increase in calcium content is observed due to the addition of milk and curd culture (Fig.6). The fermentation process enhances the calcium content in the pearl millet RTC mix. Abdel-Rahaman *et al.* (2008) observed an increase in both total and available amounts of calcium, iron and phosphorous after 14 hr of pearl millet lactic acid fermentation. According to Odumodu (2007), fermentation was found to enhance both the macro elements and the micronutrients of the fermented grains up to 72 hr.

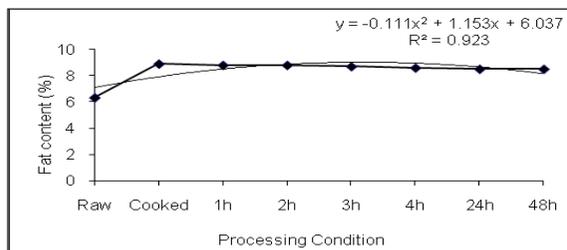


Fig. 5 . Changes in fat of RTC mix at different processing condition

3.5 Effect of processing and fermentation on phytic acid of RTC pearl millet mix

Fig. 8 shows the slight decrease while cooking and then gradual decreases in phytic acid content is observed during fermentation. Phytic acid is heat-stable, significant heat destruction of Phytic acid occurs during cooking.

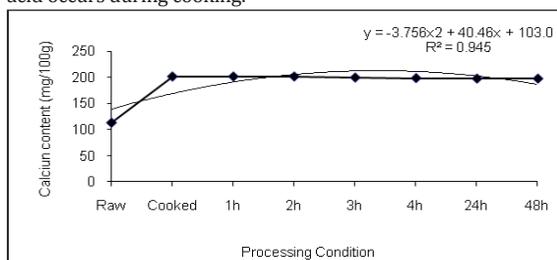


Fig. 6 Changes in calcium content of RTC mix at different processing condition

Providing plants with heat-stable phytases or addition of exogenous heat-stable phytases are seen as possibilities to improve phytate dephosphorylation during cooking (Greiner and Konietzny, 1998).

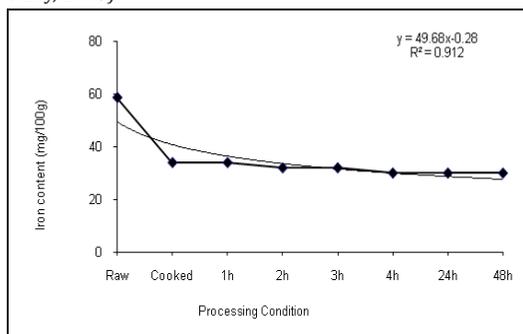


Fig.7 Changes in iron of RTC mix at different processing condition

The decrease in phytic acid is observed with increase in fermentation time was observed in the present study. The type of microorganism, the fermentation conditions used, and the starting amount of phytic acid present in the raw material significantly affect the extent of phytic acid removal during the fermentation process.

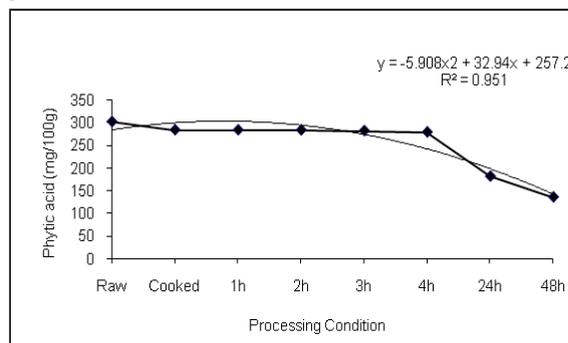


Fig.8 Changes in phytic acid content of RTC mix at different processing condition

Major fermentation microorganisms include lactic acid bacteria, moulds and yeast (Graham *et al.*, 2000). Elk halil *et al.*, (2001) used both malting and natural fermentation process alternatively and achieved up to 83% reduction in phytate. The reduction in phytic acid indicates the increase in available phosphorous content. The enzyme hydrolyses the bond between protein-enzyme-mineral to free more phosphorus (Nnam, 2000).

Conclusion

Food fermentation covers a wide range of microbial and enzymatic processing of food and ingredients to achieve desirable characteristics such as prolonged shelf life, improved safety, and attractive flavor, and nutritional enrichment, elimination of anti-nutrients and promotion of health. This study has demonstrated that the processing of RTC mix from pearl millet using traditional methods of fermentation resulted in a significant reduction of phytic acid and hence increases the availability of phosphorous. The increase in fat, protein and calcium and decreases in moisture content and pH were observed. Fermentation process did not make any significant changes in iron content.

REFERENCE

- Abdelrahman, S.M., H.B. Elmaki, W.H. Idris, A.B. Hassan, E.E. Babiker and A.H. El-Tinay. (2007). Antinutritional factor content and hydrochloric acid extractability of minerals in pearl millet cultivars as affected by germination. *Int. J. Food Sci. Nutr.* 58:16-17.
- Abdelhaleem, W. H., El Tinay, A. H., Mustafa, A.I. and Babiker, E.E. (2008). Effect of fermentation, malt-pretreatment and cooking on antinutritional factors and protein digestibility of sorghum cultivars. *Pakistan Journal of Nutrition*, 7; 335- 341.
- Desikachar HSR (1975) Processing of maize, sorghum and millets for food uses. *J Sci Ind Res* 34:231-237.
- Elkhalil, E.A.I., A.H. El-Tinay, B.E. Mohamed and E.A.E. Elsheikh. (2001). Effect of malt pretreatment on phytic acid and in vitro protein digestibility of sorghum flour Department of Food Science and Technology, Faculty of Agriculture, University of Khartoum, Shambat, Sudan.
- Graham, R.D., Humphries, J.M., and Kitchen, J.L. (2000). Nutritionally enhanced cereal. A sustainable foundation for a balanced diet; Asia Pacific *J Clin Nutr*; 9:S91-S96.
- Greiner, R. and Konietzny, U. (1998). Endogenous phytate-degrading enzymes are responsible for phytate reduction while preparing beans (*Phaseolus vulgaris*). *J. Food Process. Preserv.* 29; 321-331.
- Hulse, J.H., Laing, E., and Pearson, D.E., Sorghum and the millets: their composition and nutritive value. Academic press, New York, NY, 1980.
- Khairwal IS, Ram C and Chhabra AK. 1990. Pearl millet seed production & technology. New Delhi, India: Ramesh Jain Manohar Publications. 224 pp.
- Khetarpaul N, Chauhan BM. 1989. Effect of fermentation on protein, fat, minerals and thiamine content of pearl millet. *Plant Foods Hum Nutr.* 39(2):169-77.
- Kumar, A. and B. M. Chauhan. 2006. Chemical composition and utilization of pearl millet sprouts. *Food / Nahrung* Volume 37, Issue 4, pages 356-363.
- Latta, M. and Eskin, M. (1980). A simple and rapid colorimetric method for phytate determination. *Journal of Agricultural and Food Chemistry*, 28; 1315-1317.
- Mohamed, E. A., Ali, N.A., Ahmed, S.H., Mohamed Ahmed I. A., Babiker, E.E. (2010). Effect of radiation process on antinutrients and HCl extractability of calcium, phosphorus and iron during processing and storage. *Radiation Physics and Chemistry*, 79, 791-796.
- Nnam, N.M., 2000. Evaluation of effect of sprouting on the viscosity, proximate composition and mineral content of hungary rice, acha (*Digitaria exilis*) flours. *Nig. Food J.*, 18: 57-62.
- Odumodu, C.U. (2007). Optimum fermentation period for micronutrients content of cereal based complementary food. *Pakistan Journal of Nutrition*, 6; 518-523.
- Shimelis, E.A. and Rakshit, S.K. (2008). Influence of natural and controlled fermentations on α -galactosides, antinutrients and protein digestibility of beans (*Phaseolus vulgaris* L.). *International Journal of Food Science and Technology*, 43; 658-665.
- Vaintraub, I.A. and Lapteva, N.A. (1988). Colorimetric determination of phytate in impurified extracts of seeds and the products of their processing. *Animal. Biochemistry.* 175:227-230