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Preparation of semolina from foxtail millet (*Setaria italica*) and evaluation of its quality characteristics

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ABSTRACT

Foxtail millet was evaluated for its potential to prepare semolina. It was observed that the millet needed pre-treatment to obtain uniform sized semolina fractions. The pre-treated millet was evaluated for dehusking efficiency, hardness, color and milling yield of the semolina fractions. It was observed that steaming was beneficial compared to roasting and dry heat treatment. The millet steamed for 15 min was polished to two different grades and milled to prepare coarse and fine semolina. The yield of the coarse semolina was 75% and that of the fine semolina was 18%. It was observed that fat, protein, dietary fiber and ash contents decreased with increase in the degree of polishing. The fine semolina fractions contained slightly higher fat and protein contents compared to their coarse counterpart. The solubility index of coarse fractions was higher than that of the fine fractions at ambient temperature and the trend reversed at 97 °C. The gelatinization temperature of fine fraction was comparatively higher than that of the coarse semolina while viscosity parameters were higher for the coarse semolina compared to the fine fraction. The studies indicated that the millet with 3% polishing was suitable for the preparation of semolina with retained nutrient contents.

1. Introduction

Foxtail millet (*Setaria italica*) also called Italian millet, is one of the oldest cultivated cereals, with its origin in China and subsequently extending into India and most of Africa and parts of the southern United States. China ranks first in production of foxtail millet in the world (Liu et al., 2012). Foxtail millet plays a very important role in the agriculture and food of many developing countries because of its ability to grow under adverse heat and limited rainfall conditions (Prashant et al., 2005). Foxtail millet is an excellent source of vitamins, minerals and protein with its essential amino acid profile but for lysine (Matz, 1991). Apart from the major nutrients, it is a good source of tocopherols and exhibits good antioxidant potential (Asharani et al., 2010; Suma and Urooj, 2012, Chandrasekara and Shahidi, 2012). Millet oil could also be a good source of natural oil rich in linoleic acid and tocopherols (Liang et al., 2010). In addition, protein from foxtail millet improves cholesterol metabolism (Choi et al., 2005). Millet possesses the highest amount of sitostanol among cereal grains which lowers the level of serum cholesterol (Narumi and Takatsuto, 1999). It is also reported that germinated foxtail millet can be a good source of gamma amino butyric acid (GABA) (Bai et al., 2008).

Foxtail millet is morphologically similar to rice containing husk as a separate entity. Pawar and Machewad (2006) reported that husk forms about 13.5% (w/w) of the grain component. The endosperm of the grain is covered by bran layer and the germ forms a very small proportion (about 1.5–2%). The millet is processed by dehulling to remove husk, the non-edible component of grain. Dehulled grains can be polished to remove bran and pearled grains can be cooked into discrete grains similar to rice or further subjected to size reduction and the flour can be used in many traditional as well as contemporary products (Ushakumari et al., 2004).

Semolina is a gritty, coarse particle of wheat obtained after bolting the flour. Because of its versatility, semolina is a popular ingredient both in Asian and Western cuisines. Semolina is classified as coarse and fine, based on its particle size. Because of the size,

List of abbreviation: AAS, atomic absorption spectroscopy; GT, gelatinization temperature.

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semolina cooks faster than the native grain. Semolina from rice and corn are also prepared and marketed to some extent. Foxtail millet has not been exploited for the preparation of semolina so far. The millet being a good source of protein, complex carbohydrates, dietary fiber and carotenes, offers many health benefits for the population at risk of diabetes, obesity etc. Moreover, widespread utilization of the millet also is still limited mainly because of the non-availability of a variety of food products in the market (Choudhury et al., 2011). Millet is either used as whole grains or milled to prepare flour and used in some traditional recipes. However, exploiting the millet for preparation of semolina may increase the diversified usage of the millet in different products such as spaghetti, pasta etc., as a composite ingredient along with wheat semolina. Moreover, semolina, being one of the convenient forms to use cereals, may be used in a number of traditional and contemporary recipes either to replace partially or fully the major cereals, thus offering the health benefits associated with millets to the consumers. Hence, the main objective of this work was to process the foxtail millet to enable preparation of semolina from it and evaluation of its quality characteristics.

2. Materials and methods

2.1. Materials

Foxtail millet (Variety PS-4), procured from the University of Agricultural Sciences, Dharwad was cleaned to remove impurities like, chaff, stones etc. The cleaned millet was stored in the plastic containers and used for the studies. The initial moisture content of the sample was 12 ± 1 g/100 g.

2.2. Chemicals

Reference mineral standard solutions for atomic absorption spectrometry (AAS) were procured from Merck Specialities Pty. Ltd, Mumbai, India. All other chemicals used were of analytical grade.

2.3. Processing

2.3.1. Deshusking

Cleaned millet was dehusked in an impact huller (Kisan Krishi Yantra Udyog, Kanpur, India). The dehusked millet was converted into grits using a roller mill. Preliminary experiments showed that, both dehusking efficiency and uniformity in particle size of semolina were better with hydrothermally processed millet compared to raw millet. Hence, the millet was pretreated before conversion into semolina.

2.3.2. Pre treatment

The millet was steeped in water at ambient conditions for 8–10 h and the excess water was drained off. The steeped material was spread in steel trays (80 × 40 × 3 cm) to about 2.5 cm bed thickness and exposed to live steam (98±1 °C) at atmospheric pressure in an autoclave (Krauss Maffee Munchen, Germany) for different time intervals ranging from 5 to 40 min with 5 min increment, in different batches. The steaming time was noted as the duration between the temperature probe fitted to the autoclave indicating 98 °C and closure of the steam inlet valve. The steamed millet was dried for 2 h in a mechanical drier maintained at 45±2 °C to attain a moisture content of 11 ± 1 g/100 g. In another set of experiments, the steeped millet was subjected to dry heat treatment for 5 min using hot air at 180 °C. The control sample was also roasted for 15 min in an open pan at about 70 °C till the moisture content of the grains dropped to 9 ± 1 g/100 g. The differently processed millet samples were subjected to dehusking in the impact huller. Dehusked samples were evaluated for their color, hardness, dehusking efficiency and milling yield.

2.4. Color

The color of the product was measured by Hunter Lab (Labscan XE, Reston, Virginia) color measuring system by measuring the degree of lightness (L*), redness (a*), yellowness (b*) and also the total deviation in color ΔE from the standard.

2.5. Hardness

The individual kernels were compressed with a 50 kg load cell at a test cross head speed of 1 mm/s using a food texture analyzer (Stable Microsystem, Model TA-HDi, Surrey, UK). The maximum force required to compress the grains to 80% of their original size was recorded. The average peak force (N) value from 10 individual kernels was taken as a measure of hardness.

2.6. Polishing

Optimally processed sample namely, the millet steamed for 15 min was subjected to debranning in a cone polisher (Dahanu Industrial Works, India). The weight of the bran removed and the yield of the polished grains was noted to calculate the degree of polishing. The polished millet was separated into two different grades, under polished (3% polish) and moderately polished (6% polish) millet. Dehusked millet without any polishing was considered as millet with 0% polish.

2.7. Preparation of semolina

The millet with different treatments and the polished millets (with 0, 3 and 6% degree of milling) were roller milled using a Buhler MLU- 202 laboratory-scale mill into semolina (grits). The Buhler mill, which is a six-pass roller mill, consists of three break (B1–B3) and three reduction rolls. Each of the passages had a sifter with two siftings (above and below sifting, respectively). The B1 roll gap was adjusted to give big granular semolina with minimum flour formation. The ground stock from B1 was size graded. The reduction rolls were kept disconnected from the break rolls during the milling operations. The first scalping was further processed by break passages to produce granular semolina. The over-tails (semolina) from the flour sieves of all break passages were packed in polyethylene pouches and stored for further studies. Semolina fractions from each of the three polish grades were powdered in a domestic scale flour mill to prepare a flour of particle size less than 250 μ and used for the study of physicochemical properties.

2.8. Nutrient composition

Moisture, fat, protein and ash content of foxtail millet samples were determined according to AACC (2000) methods and the soluble, insoluble and total dietary fiber contents were estimated by the method of Asp et al. (1983). Total carbohydrates were calculated by difference method. Starch was analyzed as per Holm et al. (1986). The minerals viz., calcium, copper, zinc and iron content of the samples were estimated by atomic absorption spectroscopy.

2.9. Physical and functional properties

2.9.1. Color

Colour of semolina was measured as similar to the dehusked millets.