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Full Length Research Paper

Rate of water absorption and proximate analysis of different varieties of maize cultivated in Ikwo Local Government Area of Ebonyi State, Nigeria

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Water absorption and proximate composition of four varieties of maize; sweet corn, pop corn, white corn and yellow corn soaked at different temperatures and time duration were determined. Absorption increased with increase in temperatures and time but generally low at 45°C. The total average rate of hydration at different temperatures showed that pop corn and yellow corn absorbed water at a faster rate with the highest average rate of 0.14% per min, while white corn average hydration rate was 0.013% per min at 70°C. Proximate composition showed that protein, carbohydrate and fat were the major component of the seeds that imbibed water. The percentage crude protein of seed was at the range of 7.00 - 8.75%. Sweet corn had the highest protein content and is expected to posses the highest hydration capacity, followed by yellow corn (7.88%). Pop corn and white corn had 7.88 and 7.00%, respectively. Yellow corn had the highest total carbohydrate of 76.52%, white corn 76.00%, while sweet corn and pop corn recorded 69.25 and 74.12%, respectively. Generally, the seeds recorded low crude fat content of 0.5 - 1.5%.

Key words: Water absorption, proximate composition, sweet-corn yellow-corn, pop-corn, white-corn.

INTRODUCTION

Maize as a food grain plays a significant role throughout the world, particularly Nigeria, Pakistan and India. Its flour is used in the preparation of nutritious and tasty meals such as snacks, cakes, pizza, bread, pasta, cookies, soup and as a source of dextrose. Its bran has been found very effective in decreasing faecal transit times Bressani and Elias (1983). In order to make maize suitable for food and industrial products, milling is necessary. In making various food items, dry milling is normally adopted whereas for industrial products like starch, corn-oil and animal feeds wet milling is desirable (Burge and Dunsing, 1989).

However, to make it fit for human consumption, it must be cooked. During cooking heat gelatinizes starch making it susceptible to starch dissociating enzymes of digestive system. Starch is used by paper and textiles industries in sizing, surface coating and adhesive applications. Special starch is used in oil research for drilling mud which cools superheated drills. It is also used as anti-caking, mould release, dusting powder and thickening agents (Fasasi et al., 2005).

Maize is processed into a wide range of foods and beverages which are consumed as breakfast, main meals, or snacks. One of such foods made from maize is known as koko which is commonly fed to infants as a weaning food. It is prepared by soaking maize in water for 24 h after which the maize grains are washed and milled. Water is added to the meal produced and made into dough which is fermented for 24 h. The tin slurry is prepared by mixing a portion of the dough with water and this is cooked into porridge which is sweetened with sugar before it is given to children (Sefai-Dedh and Mensah, 1991).

Soaking operation is a preliminary step in wet milling process applicable mainly in the industrial use of maize. Soaking process has received much attention in reference to water absorption, loss of social and electrode leakage (Plahar et al., 1983). In both industrial and traditional processing, cereals and legumes are normally soaked as a preliminary operation.

Although the major objective is to soften the grains, soaking especially of certain legumes has a beneficial effect nutritionally as it reduces the level of toxic substances like trypsin inhibitors naturally present in such legumes (Kon, 1979). The same preparatory operation of soaking results in considerable nutrient loss. During the soaking process, the grains absorb moisture, swell up and some water soluble nutrients leach into the soak-water by simple diffusion. Nutrients most commonly affected are constituents such as pigments, sugar, amino acids, water soluble vitamins and mineral elements. The quantity depends on the nature of the food, volume of water used, soaking temperature and the length of soaking time (Bressani et al., 1990)

Protein is the major component imbibing water in seeds. It is expected that seeds with high percentage protein content will posses higher hydration capacity.

Soaking temperature does not exceed 70℃ to reduce losses in total solids due to leach out and gelatinization of starch (Hutton and Campbell, 1981). Studies on the hydration rate of maize will furnish useful information for predictable and economical soaking operation while taking cognizance of time (Radha and Suresh, 1996).

Proximate composition reveals the major components or constituents of a food material and confirms whether the food is normal (non-hazardous) in composition or has been adulterated or contaminated by various environmental contaminants like mycotoxins, pesticides, intentional and unintentional additives and preservatives. The natural constituents of food determined by proximate analysis are moisture content, crude protein, crude fat, ash, crude fibre (roughage) and total carbohydrate (Brassani, 1990).

The purpose of this study was to determine chemical and water adsorption characteristics of tropical maize grown at Ikwo Local Government Area of Ebonyi State, Nigeria.

MATERIALS AND METHODS

Materials

Four maize varieties (sweet-corn, pop-corn, yellow-corn and white-corn) were selected for this study to represent the range of available breeds adapted (grown) in Ikwo, Ebonyi State, Nigeria under uniform conditions in 2008 during the first rainy season (March-August). Within each breed's plot, controlled pollinations were made to avoid pollen contamination from other breeds. At maturity, the maize was hand harvested and ears with poor seed sets discarded. Ears were artificially dried at 50℃ in a dryer. The final moisture content ranged from 13 - 15%. The ears were hand shelled to minimize physical damage and were stored at 15 - 30℃ before analysis. The seeds were sorted and cleaned to remove broken, cracked or damaged ones and debris. They were graded in sizes using 4.6 and 6.7 mm mesh sieves. The seeds above 4.6 mm were used.

Determination of water absorption

A modified method of Taiwo et al. (1990) was used. 5.0 g of the seeds which have already been weighed out was soaked in 25 ml of deionized water in boiling tubes and monitored. This was applicable only for room temperatures (28℃) of the soaking water. The seeds were brought out of the water and drained for 2 min and blot dried using blotting cloth and weighed. This was done at an interval of 10 min till 1 h and then hourly interval for duration of 6 h at varying temperatures, 45, 60 and 70℃, 25 ml of deionized water was measured into water-bath (thermostatically controlled) at the required temperature. This was allowed for a while in other to create a balance in the temperature; the already weighed 5.0 g seeds of the maize varieties were added to the boiling tubes at interval of 10 min till 1 h and then at hourly. The boiling tubes were removed from water bath, the seeds were brought out drained for 2 min blotted dry to remove surface water and then weighed. The weight gained was taken as % water absorbed by 5.0 g dry seed in a dry weight basis.

Determination of protein content

Nitrogen contents of the whole seeds were determined by the micro-Kjeldahl technique (AOAC, 1990) and protein content of each sample was estimated (N x 6.25), following the method of AOAC, 1990. The technique involved the use of catalyst mixture to achieve quantitative decomposition of organic matter compounds in sulphuric acid, each nitrogen atom in the organic molecules produced one molecule of ammonia. The digestion was followed by neutralization of the sulphuric acid with sodium hydroxide. This frees the ammonia, which was removed from the mixture by steam distillation and titrated with standard hydrochloric acid.

For each ammonia molecule found in the distillate, one nitrogen atom was present in the sample. Kjedahl method of digestion, distillation and titration was used. 1.0 g of dried grounds seeds was weighed into Kjeldahl digestion flask and a pinch of catalyst mixture (2.0 g of potassium sulphate, 1.0 g of copper sulphate and a pinch of selenium powder) were added followed by 10 ml concentrated H_2So_4. The flask was then heated cautiously under fume hood until a greenish clear solution appears. After clearing, heating continued for more 30 min and allowed to cool. 10 ml distilled water was added into the digest and shaked thoroughly. Steam was passed through a Markham distillation. The digest was transferred into 100 ml measuring cylinder and diluted with distilled water until 100 ml mark. Under the condenser of the distillation apparatus, a receiver flask containing 10 ml of boric acid as indicator was placed, 10 ml of the diluted digest was introduced into the distillation unit and 10 ml of 40% NaOH solution was slowly added. The distillation was stopped by closing inlet stop cork first and then opened steam by-pass. This was titrated with 0.01 M HCl to give pink colour.

Determination of fat content

Fat content was determined by the soxhlet method (AOAC, 1984). A flask (250 ml fitted to soxhlet extractor) was washed and dried in an oven at 100℃, cooled in a desiccator. Petroleum ether (boiling range 40 - 60℃) was added. 1.0 g of each sample was placed in an extraction thimble (double thickness 22 x 88 mm). The thimble was removed and the solvent distilled from the flask. The flask was disconnected and placed in an oven at 100℃ for 2 h and later weighed after cooling.

Determination of crude fibre content

In determining the fibre content of the sample, the protein, starch, fat and other digestible carbohydrate was hydrolyzed out of the sample. The residue was then weighed and ashed to determine the organic component. The subtraction of ash content from the original

Table 1. Percentage proximate composition of different varieties of maize.

Analyate	Sweet corn	Pop corn	White corn	Yellow corn
Crude protein	8.7	7.88	7.0	7.88
Ash	0.5	0.5	1.0	0.5
Crude fibre	8.0	5.5	6.5	2.5
Crude fat	0.5	1.0	1.5	-
Moisture content	13.0	11.0	8.0	12.5
Total carbohydrate	69.25	74.12	76.0	76.0

residue gives the fibre. 2.0 g of the sample was weighed into a beaker and 180 ml preheated, 0.128 M H_2SO_4 was added and boiled for 30 min using a water pressure filter system. The moisture was filtered and residue washed 3 times with hot water. The residue was collected and 150 ml preheated 0.22 M KOH was added and boiled for another 30 min, the mixture was filtered and residue washed on the water pressure system 3 times with acetone. The residue was collected in crucible, dried at 130°C for 1 h and weighed. It was ashed in muffled furnace for 3 h at 500°C, cooled and weighed.

Determination of moisture content

The method used involved measurement of weight lost due to evaporation of water. This method gave accurate result when considered on a comparative basis. Crucibles were washed and dried in an oven at 110°C for 10 min and cooled in a desiccator. 20 g of ground samples were placed in a hot oven and dried to a constant weight at 105°C for 2 h.

Determination of ash content

Organic matters in the sample were burnt away except inorganic residue. Ashing dish was heated at 500°C for 1 h, cooled in desicator and weighed. 2.0 g of the ground sample was introduced into the dish. The dish and its content were ignited in muffle furnace gently and then at 500°C for 3 h. The dish and its content was then cooled in a desicator at room temperature and weighed.

Determination of carbohydrate content

This was determined by difference after adding the % crude protein, moisture, ash, crude fibre and fat content and subtracted from 100%.

RESULTS AND DISCUSSION

Figures 1 - 4 shows the water absorption by the four (4) varieties of maize with reference to time and temperature. It could be observed that there was high rate of water absorption initially during the first 60 min followed by slower absorption as soaking time increased. This agreed with the report of Ituem and Mittal (1985) that absorption of cereal grains exhibited the characteristic moisture absorption behavior whereby an initial high rate was followed by slower absorption in later stages. It also showed that water absorption increased.

The increased water absorption with temperature was in agreement with the report of Hoover and Maunal (1996) that the rate of hydration increased in maize with increased temperature. Soaking of seeds at elevated temperature of 70°C as the highest temperature used showed greater water absorption. This corresponds to the result of Kling (1993) that soaking at elevated temperature increased water imbibitions by beans. The average rate of hydration of the seeds at different temperatures showed that during the first 60 min interval, sweet corn absorbed more water at faster rate with average hydration rate of 0.030 and 0.033% min^{-1} at 28 and 45°C temperatures, respectively, followed by pop-corn which had 0.029 and 0.030% min^{-1} average hydration rate. Yellow corn had 0.028 and 0.030% min^{-1} while 0.021 and 0.024% min^{-1} were the least average hydration rate found in white corn at 28 and 45°C temperatures condition.

At elevated temperature of 70 and 60°C pop corn absorbed water at faster rate with average hydration rate of 0.38 and 0.0375% min^{-1} than sweet corn. White corn had the least average hydration rate of 0.029 and 0.030% min^{-1} at 60 and 70°C temperatures, respectively. The initial rapid water absorption was due to the filling of capillaries on the surface of the seed coat and at the helium. The decrease in absorption rate as soaking time proceeded was due to effect of increased extraction rate of soluble materials and filling of surface capillary and intracellular space with water (Kling, 1993).

The result of proximate analysis was shown in Table 1. Protein, carbohydrate and fat were the major components of the seed that imbibe water. Sweet corn had the highest protein content and is expected to posses the highest hydration capacity and total average hydration rate, followed by yellow corn with 7.88% protein content. Pop corn and white corn recorded 7.88 and 7.0%, respectively. Yellow corn gave the highest total carbohydrate of 76.57% and expected to exhibit high hydration characteristic. White corn had 76.00%, sweet corn and pop corn gave 69.25 and 74.12% carbohydrate content, respectively. Generally, the seeds showed low crude fat content at the range of 0.5 – 1.5%.

The rate of hydration of maize followed the same pattern as in other seed, whereby initial high rate is followed by slower rate of absorption at the later stage. Water absorption increased with increase in temperatures and time. Other intrinsic characteristics of seed

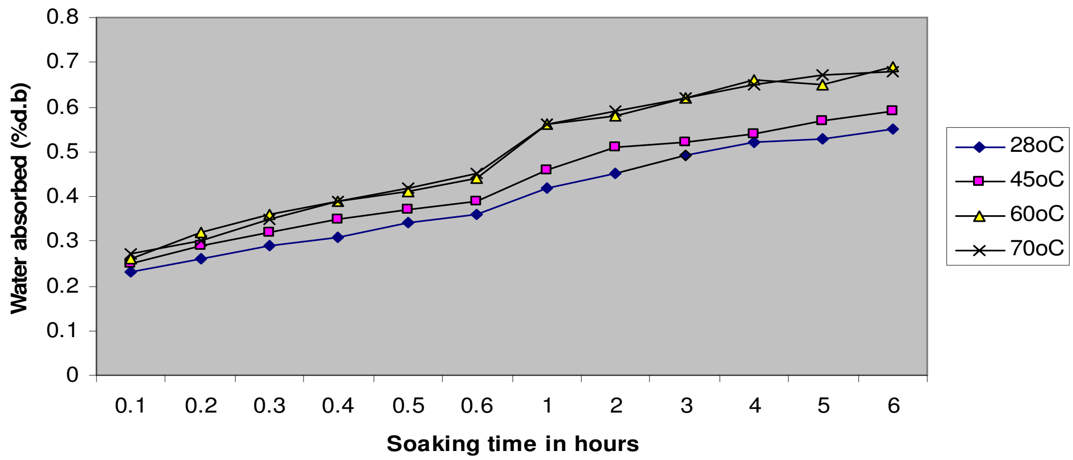

Figure 1. Water absorption of sweet-corn soaked at different temperatures (℃).

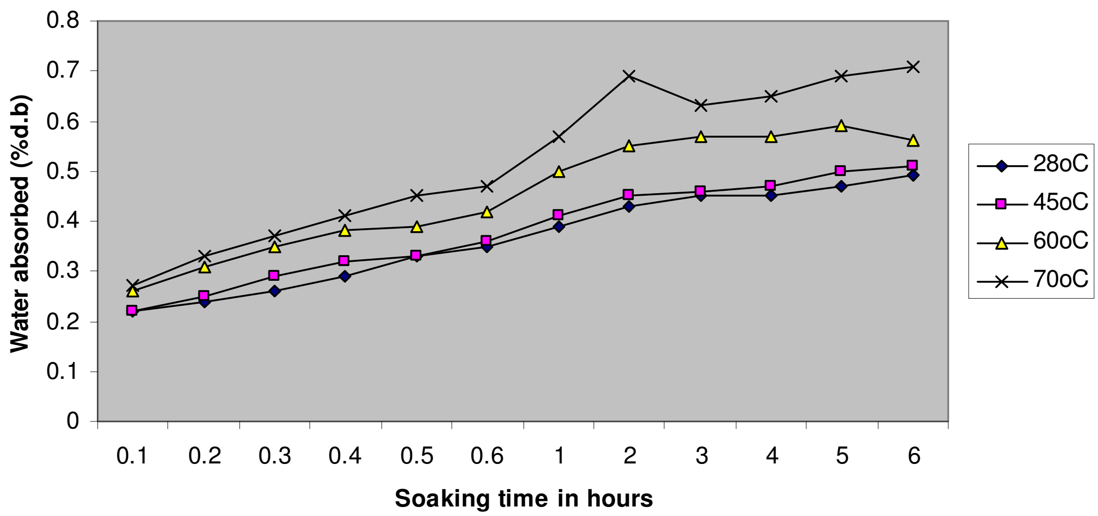

Figure 2. Water absorption of pop-corn soaked at different temperatures (℃).

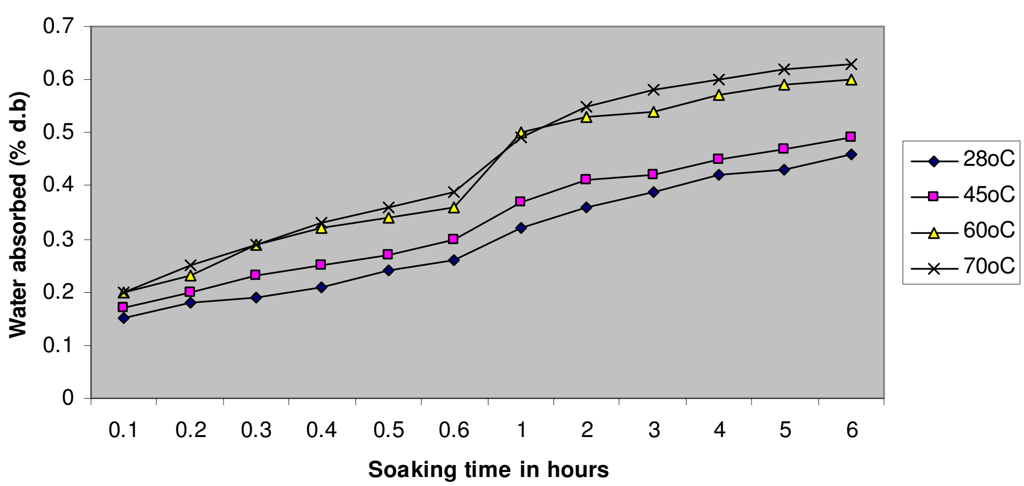

Figure 3. Water absorption of white-corn soaked at different temperatures.

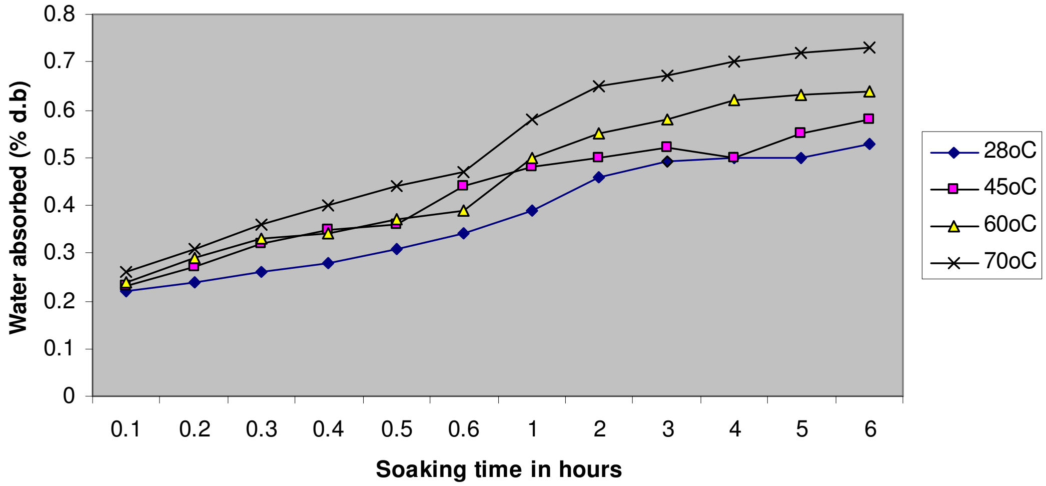

Figure 4. Water absorption of white corn soaked at different temperatures.

affect their rate of water absorption, such as percentage composition of their chemical component and seed dimension.

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