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EFFECT OF SPROUTING ON THE PROXIMATE COMPOSITION OF MAIZE SOLD IN SABON GARI MARKET, ZARIA, NIGERIA

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ABSTRACT

Proximate composition of a grain is important in that it helps in determining the quality and storage stability of grains. Hence, food processors have direct interest in the proximate composition of cereals in order to know the nature of the raw material before germination. After the fermentation of the maize grains, the proximate nutrients increased except for crude ash. The values are expressed in percentages. The moisture, fat, fibre, protein and carbohydrate contents increased by 1.18%, 0.86%, 0.03%, 0.09%, and 9.75% respectively. While the ash content decreased by 11.91%. On the other hand, the energy value of the sprouted grains is higher than that of the unsprouted by a significant value of 47.10kcal/g. This shows that the sprouting of maize appreciates significantly its nutrients and energy potentials.

Key Words: Energy, Food, Maize, Nutrients, Proximate, Sprouting.

INTRODUCTION

Cereals are grasses that are cultivated because of their edible grains. They are grown in greater quantities and provide more food energy worldwide than any other crops and are therefore called staple crops (Dary and Imhoff- Kunsch, 2012). Cereals are a part of the grass family named Gramineae. They grow dried, single-seeded fruits termed grains, consisting of seed and a fruit coat (pericarp). The grain itself contains the endosperm, embryo (germ), nuclear epidermis, and also the coat of the seed. Chemical compositions of cereals are put into the cell walls or even other barriers in components isolated from each other (Delcour, 2010). In their natural form (as in whole grain), they are a rich source of vitamins, minerals, carbohydrates, fats, oils and proteins. Cereals provide a major food resource for man. In Africa, south of the Sahara, sorghum and maize are the most popular cereals consumed by both adults and infants. They are eaten in large quantities and are the main sources of both major and minor nutrients.

Maize (*Zea mays*) is one of the world's most important cereal crops primarily grown for human consumption. It can be boiled, roasted or processed into another food like tortillas, pozole (Adesokan *et al.,* 2010). Maize is the third most important cereals after wheat and rice. The production of maize in the world was 721,000,000 acreage. Maize is an important food crop not only because it is consumed worldwide, but also due to its nutritive value. It provides more carbohydrate than wheat and sorghum and it is a good source of phosphorus. It also contains small amount of calcium, iron, thiamine, niacin and fat. Reports show that maize is an important staple food crop in Africa (Olakojo *et al.,* 2005). And it is an important food and feed crop in Nigeria and remains an important crop for rural food security. It is a staple food of great socio-economic importance in developing countries and it has a wide range of uses including: baking, brewing, starch production and livestock feed. The importance of maize cannot be overemphasized, with Nigeria producing about 43% of maize grown in West Africa. Maize is the most important staple food in Nigeria which accounts for about 43% of caloric intake. Maize is also used in making ethanol and other biofuels (Oyenuga *et al.,* 2013).

Sprouting, also known as germination is the process in which a plant emerges from a seed or spore and begins growth. The germination phase begins after the kernels have absorbed enough water to start enzyme production and starch hydrolysis. The germinating process unlocks many nutrients which are in bound forms, increases the bio-availability of nutrients, energy density and acceptability. It is widely used particularly in breaking down of certain anti nutrients, such as phytate and protease inhibitors (Brockway, 2001). The simple process of sprouting brings out many enzymes in germinated seeds, legumes and grains, making them easier to digest. Germination and fermentation of cereals is an affordable and widely practiced processing technique that has been practiced in Africa for generations. Processing methods such as soaking, sprouting and fermentation has been reported to improve the nutritional and functional properties of plant seeds (Jirapa *et al.,* 2001)

Sprouted seeds are developed by a managed germination process supervised by the producer to deliver the appropriate product, batch after batch. As sprouting is a complicated process, it is crucial to understand the occurrences of the grain and how the method is changed based on the seed and cultivation condition types to produce a higher quality product.

The kernels must meet the minimum moisture of 35%–45% and a lower temperature of 4℃ to start the sprouting of wheat (Gooding, 2009). Water moves through the micropyle into the wheat kernel, where it reaches the scutellum and germ to start sprouting and proceeds to travel across the kernel, accruing among the seed coat and pericarp (Rathjen *et al.,* 2009). If the humidity reaches the least level, the seed starts to release or/and synthesize plant hormones including abscisic acid, ethylene, and gibberellic acid. The release of these hormones in the grain stimulates the production of amylase, humiliating enzymes, lipase, and proteases (Ali *et al.,* 2021).

The proximate system for routine analysis of animal feedstuffs was devised in the mid-nineteenth century at the Weende Experiment Station in Germany. It was developed to provide a top level, very broad, classification of food components. The system consists of the analytical determinations of water (moisture), ash, crude fat (ether extract), crude protein and crude fibre. Nitrogen-free extract (NFE), more or less representing sugars and starches, is calculated by difference rather than measured by analysis (FAO, 2022)

Malnutrition is a global pandemic, the majority of people in Africa are living behind the poverty line. This is telling in their nutrition which is greatly deficient in proteins and essential minerals leading to kwashiorkor and other ailment associated with lack of balanced diet. Cereals like maize grains are the staple food available in most poor African communities, there is therefore an urgent need to look inward, in order to find ways to locally improve the essential nutrients in these grains. This may in turn improve the protein content and quality that will go a long way to augment protein deficiency in most of the African diets.

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MATERIALS AND METHODS

Sample Collection and Preparation

White maize used for this study was purchased from Sabon Gari market, Zaria, Kaduna state, Nigeria in a clean polythene bag container. It was manually sorted and washed in order to remove the spoilt grains, dust, and extraneous matter from the grain. The sorted grains were kept in a high-density polyethylene to avoid moisture uptake and contamination before use. The grain was divided into two portions of 2kg each. The first portion was sprouted by soaking in tap water (1:3w/v) for 8 hours, after which it was then spread on trays lined with jute bag and kept wet in a wooden dark cupboard by spraying water daily for three days for it to sprout. The sprouted grain was then dried in an oven at 60^{o}C for 12 hours, followed by the removal of the rootlets. It was then dry milled using attrition mill and sieved using a 425mm mesh sieve to obtain a fine germinated common white maize flour which was packaged in plastic containers and kept at 4^{o}C prior to analysis. The second part was not sprouted, but pulverized to flour and used for the analysis

Proximate Analysis

The proximate analysis was carried out in all the samples for the following nutrients: protein, carbohydrate, lipids, moisture, ash and crude fiber using standard methods described by AOAC (2005) etc.

Determination of Moisture Content

Aluminium dishes were washed and dried to a constant weight in an oven at 100ºC. They were removed, cooled and weighed (W1). 2 grams of the paste or flour sample was placed in the weighed moisture dish (W2). The dish containing the sample was kept in an oven for about 3 hours, then removed, cooled and weighed (W3). The % of moisture was calculated as: $\frac{W2-W3}{W2-W1} \times 100$

Determination of Fibre

Two grams of the sample was placed in a beaker containing 1.2ml of H2SO4 per 100ml of solution and boiled for about 5 minutes, the residue was filtered and washed with hot water then transferred to a beaker containing 1.2 grams NaOH per 100ml of solution and boiled for about 5 minutes. The residue was washed with hot water and dried in an oven and weighed (C2). The weighed sample was incinerated in a furnace of about 550ºC then removed, cooled and weighed (C3). The % fibre was calculated as: $\frac{C2-C3}{W} \times 100$

Determination of Ash

Crucibles were cleansed and dried in the oven, after drying, they were cooled and weighed (W1). 2g of the paste or flour was placed in the crucibles and weighed (W2). They were transferred into the Muffle furnace of about 550ºC then removed, cooled and weighed (W3). The % Ash was calculated as: $\frac{W3-W1}{W2-W1} \times 100$

Determination of Lipids (Fats)

250ml clean boiling flask was dried in oven, and cooled. Empty filter paper was weighed and labeled (W1). Two grams of sample was weighed into the labeled filter paper (W2). The boiling flask was filled with petroleum ether. The soxhlet apparatus was assembled and allowed refluxing for 8 hours then, removed and transferred to an oven and dried. It was then cooled and weighed (W3). The % fat was calculated as: $\frac{W2-W3}{W2-W1} \times 100$

Determination of Protein

Digestion: 2g of sample was weighed into a Kjeldahl flask. Copper catalyst and 15ml of concentrated sulfuric acid were added. It was heated in a fume cupboard till solution assumed a green colour. It was cooled and black particles showing at the mouth and neck of the flask were washed down with distilled water. The digest then washed thoroughly with distilled water.

Distillation: the Markham distillation apparatus was steamed through for about 15 minutes before use. 100ml conical flask containing 10ml of boric indicator was placed under the condenser. 10ml of the digest was pipetted into the body of the apparatus via the small funnel aperture; washed down with distilled water followed by 10ml of 40% NaOH solution.

Titration: the solution was titrated in the receiving flask using N/100 (0.01N) hydrochloric acid and the Nitrogen content and hence the protein content of the sample was calculated. The blank was run through along with the sample. The % protein was calculated as:

$$final\ reading - initial\ reading - blank(0.2) \times \frac{standard\ number\ of\ nitrogen(1.4)}{initial\ weight(0.5)} \times standard\ number\ of\ protein(6.25)$$

Determination of carbohydrate (CHO)

CHO content was determined by difference: $100 - (\%moisture + \%ash + \%protein + \%fat)$

Gross Energy Value

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The gross energy values of sprouted and unsprouted maize grains were estimated using the factors for protein (4Kcal/g), fat (9 Kcal/g) and carbohydrate (4 Kcal/g). The equation is

Food energy = (%Crude protein×4) + (%Fat content×9) + (%Carbohydrate×4) (Hagos, 2018)

RESULTS AND DISCUSSION

The chemical analysis is important in that it provides useful information to the nutritionist who are concerned with readily available sources of high protein food as well as to the food scientist who are interested in developing them into high protein foods safety for consumers (*Inass et al.,* 2021). Additionally, chemical composition could influence the storage and could assist in determining the suitability of different species to specific processing and storage methods. Hence, food processors have direct interest in the proximate composition of cereals in order to know the nature of the raw material before germination (Opstvedt, 2000).

Table1: Effect of Sprouting on the proximate composition of white maize

Nutrients	**Unsprouted (%)**	**Sprouted (%)**
Moisture	8.01	9.19
Ash	18.11	6.20
Fat	1.70	2.56
Fiber	5.99	6.02
Protein	9.19	9.28
Carbohydrate	57.00	66.75

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Proximate analysis study performed on maize vary slightly from that stated by Imran, (2015). The observed differences could be due to difference in cultural practices, environmental conditions and in cultivars and varieties. Proximate composition of a grain is important in that it helps in determining the quality and storage stability of grains.

As shown in table 1, the protein content increased by 0.09%. This agrees with the findings of Imran, 2015 on two maize varieties. Bau *et al.,* (1997) inferred that the increase was due to synthesis of enzyme proteins (for example, proteases) by germinating seed or a compositional change following the degradation of other constituents. A further explanation was done by Nonogaki *et al.,* (2010) where they noted that protein synthesis occurred during imbibitions and that hormonal changes play an important role in achieving the completion of Germination. Increase in protein content is also attributed to the activation of proteolitic enzymes present in the seeds as well as the hydrolysis of tannin – protein and enzyme protein complexes which release more free amino acids and peptides for metabolism of the embryo. Protein in seed is also degraded and converted into soluble state during sprouting. The speed of utilization of the soluble amino acids becomes faster leading to increased protein contents (Ambugus *et al.,* 2020).

The moisture content as expected increased after sprouting. This is because of water intake by the seeds during sprouting as a result of increasing number of cells within the seed becoming hydrated (Nonogaki *et al.,* 2010).

Sprouted maize shows high fibre content. This agrees with the finding of Megat *et al.,* (2016) who reported increase in dietary fibre of different cereals. This is as a result of the synthesis of structural carbohydrates such as cellulose and hemicelluloses, which are major constituents of cell walls. Fibre is the edible parts of plants, or similar carbohydrates, that are resistant to digestion and absorption in the small intestine (James and Mark, 2010). Dietary fibre has the following benefit in nutrition: it attracts water and forms a viscous gel during digestion, slowing the emptying of the stomach, shortening intestinal transit time, shielding carbohydrates from enzymes, and delaying absorption of glucose, which lowers variance in blood sugar levels. It lowers total and LDL cholesterol, which may reduce the risk of cardiovascular disease. It regulates blood sugar, which may reduce glucose and insulin levels in diabetic patients and may lower risk of diabetes. It speeds the passage of foods through the digestive system, which facilitates regular defecation. It adds bulk to the stool, which alleviates constipation (Gropper *et al.,* 2008).

The carbohydrate content increased. this agrees with the study conducted by Adebiyi *et al.,* (2017), results reported an increase in carbohydrates from 78.56 to 80.66 % after 48 h of germination, although an explanation as to what caused the increase was lacking in the study.

Table 2: gross energy values of unsprouted and sprouted maize grains

Gross energy values	**Kcal/g**
Unsprouted maize	280.06
Sprouted maize	327.16

Interestingly, the gross energy value of the sprouted maize is higher than that of the unsprouted maize by a significantly value of 47.10kcal/g. Gross energy value also known as food energy is defined as the energy released from carbohydrates, fats, proteins and other organic compounds. Accurate evaluation of the energy value of foods is essential for dealing with problems of normal nutrition, undernutrition or obesity. These values provide a satisfactory measure of available energy in average diets and food supplies (Annabel and Bernice, 1995). The chief food sources of energy to the human body are fat, carbohydrate, and protein. Fats and carbohydrates contain carbon and hydrogen which can be oxidized to their end products, CO_2 and H_2O, both in the bomb calorimeter and in the body. In addition, protein contains nitrogen. This nitrogen together with some carbon and hydrogen leaves the body chiefly in the form of urea. Thus, protein is incompletely oxidized in the body, whereas it can be completely oxidized in the calorimeter. The heat released by oxidation of food in the bomb calorimeter is its heat of combustion and is a measure of its gross energy value. (Annabel and Bernice, 1995).

However, this gross energy is not all available for the body to use. Here is where the concept of metabolizable energy comes in. Gross energy values over-estimate the energy available for metabolism. A common assumption has been that gross energy values are the correct values (Gidrewicz & Fenton, 2014). However, the convention in nutrition science is to report all foods' energy content as metabolizable energy instead of gross energy. Metabolizable energy at 4 kilocalories per gram for protein and carbohydrate, 9 kcal per gram for fat represents the food energy available for metabolism. Gross energy is about 5–10% higher than metabolizable energy (Chen *et al.,* 2003).

CONCLUSION

In this research, it is observed that sprouting significantly improved the nutritional value of maize grain by appreciating the energy value and nutrient densities of the grains.

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