THE EFFECT OF PARBOILING ON NUTRITIVE VALUES OF RICE (*Oryza sativa*)

BY

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2003/14818EA

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FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

NOVEMBER, 2008

DECLARATION

I declare that this project work is a record of a research work that was undertaken and by me. It has not been presented before for any degree or diploma or certificate at any sity or institution. Information derived from personal communications, published and published works of others were duly referenced in the text.

....

Oseh, Friday James Date
2003/ 14818EA

CERTIFICATION

This project entitled "The Effect of Parboiling on Nutritional Values of Rice (*Oryza sativa*)" by Oseh, Friday James meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is especially dedicated to Almighty God who gave me strength to complete my Programme

&

To my loving family whom God has used in diverse ways to build my career

ACKNOWLEDGEMENTS

I am most grateful to Almighty God for giving me the grace and seeing me through the completion of this project and the B. Eng. Programme.

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ABSTRACT

In this work, the effect of parboiling on nutritional values of rice (*Oryza sativa*) was determined with the view of ascertaining the quality retention properties of rice that was subjected to parboiling. This will enhance its utilization and suitability in various processes and applications. Standard laboratory conditions, methods and instruments were used to obtain the results of the experiments. The results obtained showed that parboiled, dried and milled rice has the following properties: 2.78% moisture, 4.89% crude fibre, 2.17% total lipid, 5.51% crude protein, 2.18% ash, 14.71J/g energy values, 85.34% carbohydrate, 7.82ppm calcium, 1.96ppm iron, 1.8ppm zinc, 7.94 mg/100g vitamin A, and 0.83 mg/100g vitamin C. The results show that rice parboiling leads to variation in the nutritional content of rice as demonstrated in the results obtained for Protein content which shows a decreased from 6.61% to 5.29% after the parboiling operation. The result obtained for vitamins A and C also shows decrease in the nutritional values of rice after parboiling at different temperature range (80^0C, 100^0C, and 120^0C). It can be concluded that parboiling rice leads to decrease as well as increase in the nutritional content of the product (rice).

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Rice is the staple food for more than half the world's population. Asia accounts for more than 90% of the world's total rice production; the balance is divided almost equally between Africa and Latin America, where the demand for rice is increasing. Rice has been cultivated in Asia since ancient times and for generations farmers have maintained thousands of different varieties (Jackson, 1995). These landraces, together with the 22 pan-tropical, wild species of *Oryza*, are the genetic foundation for the breeding efforts needed to sustain the productivity of rice cultivation.

Besides the landrace varieties and wild species already mentioned, the genetic resources of rice also encompass natural hybrids, commercial and obsolete varieties, breeding lines and a range of different genetic stocks. Most countries in Asia maintain collections of rice germplasm, and the largest are China, India, Thailand and Japan. In Africa, there are significant collections of rice in Nigeria and Madagascar, while in Latin America, the largest collections are in Brazil, Peru, Cuba and Ecuador. All these collections conserve landrace varieties as well as breeding materials. Information on the extent of external access to these collections and their use in breeding (both nationally and internationally) is not easily available in publicly accessible databases (Grist, 1986)

Great economic importance is attached to the production of rice in Nigeria. Its production is likely to increase with the adoption of improved technology and increase in market demand. Parboiled rice is usually defined as rice which has been steeped, heat treated and dried. During the heat treatment step of parboiling, the starch in the endosperm of the rice is substantially

gelatinized. The parboiling process and the resulting gelatinization of the starch have several beneficial effects

First, rice *(Oryza sativa)* is parboiled to achieve a better milling yield (less broken rice). Less broken rice has significant economic and quality consequences; whole rice commands a higher price because whole grains are valued by consumers of rice for high quality. Cooked whole grains are generally accepted world-wide as having a more pleasing appearance.

Parboiling also causes a very important second quality change, which becomes evident upon cooking. Cooked parboiled rice grains are significantly more intact and retain their natural shape as compared to non-parboiled rice. In selected rice eating cultures of the world, this is viewed as a quality improvement over non-parboiled rice (FAO, 1998).

Also, during the parboiling process, the rice grain is strengthened to the rigours of abrasive milling (unparboiled rice is easily shattered); the strengthening of the grain is manifested in the cooked finished product. The rice is so strengthened by parboiling that it typically takes longer to cook during preparation but often has a firmer texture and is less sticky than unparboiled rice. Even with the cooking time increase, these changes make parboiled rice more attractive than unparboiled rice in selected cultures around the world (Yah, 1992).

Parboiling of rice apparently originated, principally in India. In the early history of parboiling, the rough (paddy) rice was simply soaked in warm water overnight and then dried in the sun (FAO, 1998). The perceived benefit was that the rice hulls were split open and were easily removed from the rice kernel. In modern times, it has been realized that parboiling also provides more nutritional rice as thiamine and other essential nutrients, which are normally present in the rice bran migrate to the rice endosperm during the water steeping or soaking step. Since almost all rice is milled to remove the bran, this migration preserves at least some of the nutritional values

initially contained in the bran. Parboiling is also beneficial since the starch in the endosperm is changed in the amorphous state; the kernel is tougher, resulting in a higher yield of whole rice kernel after milling. As mentioned earlier, unparboiled (crystalline) rice easily shatters. Gelatinization via parboiling simply put, is the water assisted melting of starch granules upon heat treatment. The presence of too much or too little water when heat is applied to the starch can have beneficial or deleterious effects. Another significant benefit of parboiling is that the lipase in the bran layer of brown rice becomes inactivated due to the heat treatment. This improves the shelf life of parboiled brown rice by reducing the tendency for oxidative rancidity.

1.2 Statement of the Problem

In Nigeria and many other countries in Africa once rice has been harvested, storing, processing, washing and cooking practices can all influence its nutritional quality; nevertheless, postharvest losses are rarely taken into account in nutritional assessment. Post-harvest losses do not affect the nutrient composition directly, but the magnitude of rice lost during this period can have a profound impact on food security.

1.3 Objectives of the Study

1. To analyze unparboiled and parboiled rice samples for proximate compositions.
2. To determine the effect of parboiling on proximate compositions of rice.

1.4 Justification of the Study

Since rice has become one of the major foods widely consumed in the continent, it is imperatively important to analyze and determine the effect of parboiling on its nutritive contents. Parboiled rice is one of the most popular rice products in the world and becomes more important not only by the fact of improved nutritional value but also by the improved cooking and processing properties which are desirable from the industrial standpoint. Apart from the

nutritional importance of parboiled rice there are plenty of advantages and effects which make parboiling attractive. These advantages are the increased head rice yield during milling of parboiled rice, the reduced stickiness of the cooked rice and the improved cooking behaviour of the parboiled rice. There are currently a lot of traditional and industrial methods where the basic steps like soaking, thermal treatment (steaming or cooking) and drying often only differ by the application of different techniques and process parameters (FAO,1998). In rice producing countries generally paddy (raw rice) is used for parboiling.

Apart from a constant quality, the rice industries require special quality specification of the products, where cooking texture and processing properties are in the form as quality features. A necessary pre-requisite for this is the knowledge of the certain impacts of process parameters to different rice varieties and quality aspects on the final product. To achieve this aim, parboiling equipment is needed which permits the selection of adequate processing parameters according to individual customers.

1.5 Scope of the Study

The scope of this project work is limited to the effect of parboiling on nutritive value of rice *(Oryza sativa)*. The nutritional contents to be assessed or analyzed are; moisture content, crude fibre content, protein content, ash content, calories content, vitamin content, Iron content, zinc content, calcium content and carbohydrate.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Historical Evolution of Rice

Rice, of all the staple food crops, accounts for the dietary energy requirements of almost half the world's population. Over 90% of the world's rice is produced in Asia. It is the second most important crop in the world (after wheat, which has an annual cultivation area of 213 million hectares and is grown annually on 151.54 million hectare, with an annual production of 593 million tonnes and an average productivity of 3.91 tonnes per hectare (FAOSTAT, 2002). The four decades since 1961 have seen an increase in area, production and productivity of rice of 31.2, 174.9 and 109.7 percent, respectively. Besides Asia, rice is grown in America, Latin Africa, the United States and Australia. It is also grown to a very limited extent in the European Union.

Rice, throughout history, has been one of man's most important foods. Today, this unique grain helps sustain two-thirds of the world's population, yet little is known about the origin of rice cultivation. Archeological evidence suggests rice has been feeding mankind for than 5,000 years. The first documented account is found in a decree on rice planting authorized by a Chinese emperor about 2,800 BC. From China to ancient Greece, from Persia to the Nile Delta, rice migrated across the continents, eventually finding its way to the western Hemisphere (USDA, 1999).

Enterprising colonists were the first to cultivate rice in America. It began quite accidentally when, in 1685, a storm-battered ship sailing from Madagascar limped into the Charles Towne harbour. To repay the kindness of the colonists for repairs to the ship, the ship's captain made a gift of a small quantity of "Golden Seed Rice" (named for its colour) to a local planter. (De Lucia and Assennato, 1994)

The low-lying marsh lands bordered by fresh tidal water rivers of the Carolinas and Georgia proved to be ideal for rice production. The soils were rich, reasonably flat and highly fertile. They also were so soft that a man could hardly stand on them, with twice a day tides pushing fresh river waters onto the flood plains, nothing else could be grown there.

By 1700, rice was established as a major crop for the colonists. That year 300 tonnes of American rice, referred to as "Carolina Gold Rice", was shipped to England. Colonists were producing more rice than there were ships to carry it. (De Lucia and Assennato,1994)

2.2 Relationship between Rice and Other Grains

In West Africa, rice is considered to be the first of all cereals. Serving rice as a diet at festivals or important ceremonies is always a good choice because of its fine and delicious taste and is also known for its nutritional properties (NRC, 1996).

Although, the protein content of rice is similar or slightly lower than that of other grains, it contains amino acids like methionine and cystine, which are essential to human health. These are often deficient in today's major cereals (NRC, 1996). As rice is known to be easy to digest, it is traditionally recommended for children, old people which cannot digest other cereals, sick people and people suffering from diabetes or stomach diseases. Local pharmacists also recommend it for people who want to lose weight. Bicereal (for a long time is referred to as 'cereal of the poor')is attracting renewed interest in the urban areas of West Africa because of its cooking and nutritional qualities.

Despite its economic and cultural importance, however, knowledge of the distribution and genetic diversity of rice remains relatively limited. This is because, scientific research has generally been directed towards the better-known crops like sorghum, pearl millet and maize.

2.3 Processing of Rice

Rice grain is handled in traditional ways. The plants are usually cut with a knife or sickle, tied into sheaves, dried, and stored under cover. Good yields are normally 600-800kg/ha, but more than 1,000kg/ha has been recorded. In areas in Africa, yields may drop below 500kg/ha and on extremely poor soils may be merely 150-200kg/ha. Rice plant shatters easily when they are mature, so much of the grain is lost between harvesting and processing rice. Also, threshing and dehusking rice takes a great deal of time and current method often contaminates the final product with sand. Traditionally, the grain is threshed by beating or tramping, and it is dehulled in a mortar (NRC, 1996).

Processing rice is a difficult and time-consuming task because of the extremely small size of the grain. One gram of rice contains nearly 200grains and each egg shaped grain, is only about 1-1.5mm long. After threshing, the grain is still surrounded by husks. This product is called 'rice paddy' or 'raw rice' (NRC, 1996). Like acha, processing paddy into whitened rice is done in two stages. The first stage known as dehusking or peeling, involves removing the husks from the seed to obtain the dehusked grain. The second stage known as whitening aims to remove the bran (the pericarp and the germ) from the grain. Dehusking and whitening of the grain are done by hand and require four to five successive beatings using a pestle and a mortar alternated with many winnowing. The productivity of this work is very low. It takes nearly one hour to peel just one or two kilogram of paddy. Moreover, in order to obtain a quality product, all dirt and sand must be eliminated. Thus, mechanizing the processing and the cleaning of rice is essential both to reduce the painstaking work and to improve the quality and availability of the marketed product.

Rice cropping cycles vary from 70 to 150 days depending on the variety. Varieties with a very short cycle (70-85 days) allow the farmers to harvest early and enable them to cover the

critical 'hunger' season before the major food crop. The late varieties, in particular are well adjusted to poor soils and the small grass resist periods of drought and heavy rain.

2.4 Factors Influencing the Nutrient Composition of Rice

Post Harvest Losses

Post harvest loss is defined as a measurable quantitative and qualitative loss in a given product (De Lucia and Assennato, 1994). The loss can occur at any point during harvest, threshing, drying, storage or transport. An estimated 10-37% of total rice production is lost due to post harvest factors (Saunders, 1979). During harvest, depending on the type of machinery or manpower used, small amounts of the grain will be left in the field. Similarly, losses may occur during the drying process, which in developing countries commonly takes place on the roadside. Further losses are incurred during the storage process due to molds, insects and rodents. Estimates from Sub-Saharan Africa have shown rodents can consume of contaminate up to 20% of a stored harvest (FAO, 1994). Estimates of post harvest rice losses in Southeast Asia are provided in table five

Milling

After harvesting, rough rice or paddy rice is dried, either mechanically or by open-air. Dried rice is then milled to remove inedible hull. Hulled rice is also called "brown" rice and consists of an average weight of 6-7% bran, 90% endosperm and 2-3% embryo (Chen et al., 1998). Further milling removing the bran layer yields white rice. On average, paddy rice produces 25% hulls, 10% bran, and 65% white rice (Saunders, 1979). After industrial milling, 100kg of paddy yields about 60kg of white rice, 10kg of broken grains, 10kg of bran and flour, and 20kg of hulls (FAO, 1994).

Washing and Cooking

Washing rice prior to cooking is estimated to lead to losses of 2-7% protein, 20-41% potassium, 22-59% thiamin, 11-26% riboflavin and 20-60% niacin. (Juliano, 1993). Losses from washing and cooking methods used in India were calculated at 10% protein, 75% iron, and 50% calcium and phosphorus (Grist, 1986). Cooking in excess water that is discarded can lead to thiamin losses of 30-50%, thiamin (Saunders, 1979).

Table 2.1 compares the nutrient values of equal portions of raw and cooked rice. Rice expands during cooking as water is absorbed. One hundred grams of raw white rice yields approximately 232 grams of cooked white rice, and 100 grams of raw brown rice yields 263 grams of cooked brown rice (Banjong *et al.*, 1995).

Table 2.1: Energy in 100g Raw and Cooked Rice.

Type of Rice	Energy kJ/100g	Energy kcal/100g
Brown Raw	1506	360
White Raw	1519	363
Parboiled Raw	1544	369
Brown Cooked	498	119
White Cooked	456	109
Parboiled Cooked	444	106

Source: Adapted from Saunders 1979. (Conversion 1kcal= 4.184 kJ)

Storage

As noted in take five, 2-6% of rice harvest may be lost during storage. These losses are incurred due to infestation by insects, mold and consumption or contamination of the grain by rodents and birds. Parboiling rice has been shown to decreases post-harvest losses during storage due to insects (Bhattacharya, 1985). Similarly, certain traditional rice varieties have proven to be less

vulnerable to attack by insects when compared to high yielding varieties (FAO 1994). Vitamin content, particularly thiamin, has been seen to decrease during rice storage (Juliano *et al.*, 1985). However, it was found that the loss of B vitamins during storage was less in parboiled rice (Bhattacharya, 1985).

2.5 Parboiling Of Rice

Parboiling is a hydrothermal treatment given to paddy to improver its qualities and it involves the three basic processes of soaking (or steeping), steaming and during (Ezeike, 1987). The benefits of parboiling are an increase in total head yield of paddy, reduction of loss of nutrients during million, salvaging of damaged paddy, reduced incidence of breakage during milling etc. parboiling is an ancient process which is practiced in Bangladesh, Burma, India, Sri Lanka and other parts of the world, for improves the quality of rice that is to be used for human consumption (Ali and Ojha 1975). Parboiling improves head rice recovery (Pandya, 1977) and it is estimated that about 20% of total paddy produced in the world is parboiled (Bhattacharya, 1979), traditional parboiling practice involves soaking paddy in water at room temperature for 24-76 hours. Soaked paddy is subsequently placed in a metal drum with a fire underneath and stirred continuously to avoid localized heating and burning. Steam generated in this process heats the paddy to the gelatinization temperature of 59-71°C (Juliano, 1984). Finally, the gelatinization paddy is dried by spreading in the sun pr by the use of mechanical dryers.

During the last few years modern methods have been developed for large-scale parboiling at the mill level (Gariboldi, 1973; Ail and ojah, 1976). Paddy is soaked in warm water in large tanks. After soaking, water is drained out and steam is injected through pipes which are imbedded in the grain. The hot steam gelatinizes the starch. However, modern parboiling methods are quite capital-and energy-intensive, and are not suitable for village-level, small-scale operations.

Approximately 1.04 x 10^9 J of heat is required to parboil a ton of paddy with the modern methods and about 6.8 x 10^8 J of this is consumed during the steaming and subsequent during operation (Ali and Ojah, 1976; Wimberly, 1983). If gelatinization and drying operations could be combined, one operation could have been eliminated from the parboiling operations. This can result in considerable savings of energy. The elimination of soaking in water and combing the steaming and final drying operations were first suggested by Jones (1946), for paddy which may be harvested at sufficiently high moisture levels. Very little work however has been done so far to simplify the traditional small scale parboiling process which is still practiced extensively in many parts of Asia and Nigeria.

2.6 Uses of Rice

In Nigeria, rice is used as the following:

Cooked rice for breakfast

Rice flour for *Tuwo Shinkafa and Masa*

Rice is also used for *Kunu Zakki*

Rice is believed by some to have medicinal properties. Although, this is not scientifically proven effective, it has been used in many countries for medicinal purpose. For example:

Philippines: Rice polishing-the bran-is extracted and used as an excellent source of Vitamin B to prevent and cure beriberi.

Malaysia: In the Medicinal Book of Malayan Medicine, it is prescribed that boiled rice "greens" can be used as an eye lotion and for use with acute inflammation of the inner body tissues. The book also recommends applying a mixture of dried, powdered rice on certain skin ailments.

Cambodia: The hulls (husk) of mature rice plants are considered useful for treating dysentery. The hulls of a three-month old rice plant are thought to be diuretic.

China: The Chinese believe rice strengthens the spleen, as well as "weak stomach," increases appetite, and cures indigestion. Dried sprouted rice grains were once used as an external medicine to aid in digestion, give tone to muscles, and expel gas from the stomach and intestines.

India: Rice water is prescribed by the Pharmacopoeia of India as an ointment to counteract inflamed surface (UNICEF, 2001).

2.7 Proximate Compositions of Rice

Nutrients are classified as essential or non essential. Non essential nutrients are manufactured in the body and do not need to be obtained from food. An example is cholesterol (a fat like substance present in all animal cells). Essential nutrients must be obtained from food sources such as rice, because the body either does not produce them or produces them in amounts too small to maintain growth and health. Essential nutrients include water, carbohydrates, proteins, fats, vitamins, and minerals. An individual needs varying amounts of each essential nutrient, depending upon such factors as gender and age. Specific health conditions, such as pregnancy, breast-feeding, illness, or drug use, make unusual demands on the body and increase its need for nutrients. Dietary guidelines, which take many of these factors into account, provide general guidance in meeting daily nutritional needs (Anderson, 1980).

Moisture Content

Moisture content is the amount of water present per given weight of sample. In other words, moisture content is the loss in weight of the sample during drying. Moisture is removed in

other to know the storage ability of the product at its certain moisture content, by so doing, improve the shelf life and eliminate or reduce oxidative rancidity, microbial activities and other infestations.

Calories Content of Rice

In many regions, rice is eaten with every meal and provides more calories than any other single food. According to FAO (2000), rice supplies an average of 3.72 kJ (889 calories) of energy per person per day in Asia. In contrast, rice provides an average of only 343J (82 calories) per person per day in America. Rice is a nutritious food, providing about 90% calories from carbohydrates and as much as 13% of calories from protein. Once digested, carbohydrates, proteins and fat provide the body with the energy it needs to maintain its many functions. Scientists measure this energy in kilocalories (the amount of energy needed to raise 1kg of water by 1°C). In nutrition discussions, scientists use the term calories instead of kilocalories as the standard unit of measure in nutrition.

Protein Content

Proteins literally hold the first place in the architecture and machinery of all living things. Without them no life can exist. No plant can grow or trap sunlight; no body can be born on reared unless proteins have been made. The proteins can be plant proteins or animal proteins. They are different but all built up from the same 20 building blocks called essential amino acids. When amino acids combine to form protein they do it through the NH_2 group of one amino acid reacting with the OH of another. Amino acids of importance in human diet are: histidine, isoleucine, leucine, lysine, methionine, phenylanine, threnine, tryptophana and valine (Bouis, 1996).

begin to germinate (Encarta, 2008).

Crude Fibre Content

Vegetables, fruits, grains, and legumes constitute a rich source of dietary fibre. Composed of the indigestible cell walls of plant material, fibre acts like a scouring pad to cleanse and flush the digestive tract. Researchers claim it helps eliminate cancer-causing chemicals and may decrease the amount of cholesterol in the blood stream.

Vitamin Content

Vitamins are organic substances or compounds needed in very small amount in human body that perform a specific metabolic function and must be provided in the diet of man and animals. Plants can manufacture vitamins from the elements available to them from the soil. The water soluble vitamins are those soluble in water and are heat labile. They include vitamin C, vitamins B1, B_2, B_3, B_6 and B_{12}, (ascorbic acid, thiamin, riboflavin, niacin, pyridoxine and cobalamine respectively). The fat soluble vitamins are present in fats and are not heat labile. They include vitamin A (retinol), vitamin D (cholecalciferol), vitamin E (Tecophenols) and vitamin K (Naphthoquinones) (Popkin *et al.*, 1993).

Iron Content

Haemoglobin is contained entirely in the red blood cells, amounting to perhaps 35% of their weight. To combine properly with oxygen, red blood cells must contain adequate hemoglobin. Haemoglobin, in turn, is dependent on iron for its formation. A deficiency of haemoglobin caused by a lack of iron in the body leads to anaemia (Anderson, 1980).

Zinc Content

Zinc minerals are minute amounts of metallic elements that are vital for the healthy growth of teeth and bones. They also help in such cellular activity as enzyme action, muscle contraction, nerve reaction and blood clotting.

Calcium Content

Nutritionists recommend meeting our calcium needs with foods naturally rich in calcium such as rice. Adequate calcium intake in childhood and young adulthood is critical to achieving peak adult bone mass, yet many adolescent girls replace milk with nutrient-poor beverages like soda pop. According to bone health requires a lot of nutrients and one is likely to get most of them in dairy products. They are a huge package rather than just a single nutrient. With so many low-fat and nonfat dairy products available, it is easy to make dairy foods part of a healthy diet. People who have trouble digesting milk can look for products treated to reduce lactose. A serving of milk or yogurt contains about 350 milligrams (mg) of calcium. Fortified products have even more.

People who don't consume dairy foods can meet their calcium needs with foods that are rich with calcium, such as rice or fortified food such as orange juice, or with calcium supplements. Other good sources of calcium are *broccoli* and dark-green leafy vegetables like kale, tofu (if made with calcium), canned fish (eaten with

bones) and fortified bread and cereal products(Chen *et al.*, 1998).

Nutrition labels can help you identify calcium-rich foods. Calcium is critical, but even a high intake would not fully protect you against bone loss caused by estrogen deficiency, physical inactivity, alcohol abuse, smoking, or medical disorders and treatments.

Ash Content

These are inorganic compounds, which appear in food analysis i.e. they are substances left behind, when the carbon, hydrogen and nitrogen (organic compounds) have all been burnt off by excess oxygen. In other words, ash of a biological material is an analytical term for the inorganic residue that remains after the organic matter has been burnt off. An adult may have over 1kg of calcium in his body, whereas of chromium he has only 5-10mg and of copper 150mg (NRC, 1996).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials

The rice sample (long grains) used to determine the nutritional contents were obtained from Minna Main Market, Niger State, Nigeria. The rice grains were used as obtained. The tests and analyses were carried out at The Federal Polytechnic Bida, Chemistry Laboratory and Animal Production Laboratory at Federal University of Technology Minna.The official method of analysis of Association of Official Analytical Chemist, AOAC (1980) Guidelines for Determining Nutritional Parameters was used for the determination of nutritional composition of rice between 8^{th} and 29^{th} of August, 2008.

3.2 Reagents and Instruments

The reagents and instruments are:

3.2.1 Reagents

Tetraoxosulphate (VI) acid, (H_2SO_4)

Sodium hydroxide (NaOH)

Calcium chloride ($CaCl_2$)

Calcium hydroxide ($Ca(OH)_2$)

Boric Acid

Methyl orange indicator

Filter paper

Ammonium chloride solution (NH_4Cl)

Petroleum ether

Selenium tablet

2, 6 – dichlorophenol – indo – phenol

Hydrogen chloride (HCl)

Anhydrous sodium carbonate

Tri - floro acetic acid (TFA)

Chloroform

3.2.2 Instruments / Apparatuses

Crucibles

Furnace (Lento (England), serial number 4099)

Petri dishes

Desiccators

Weighing balance (with sensitivity of 0.001g, serial number HS2764, metler (Switzerland))

Filter paper

Oven (Gallenkamp oven 3,000 plus series, Gallenkamp (England), serial number 206 2P 29N)

Soxhlet extractor flat bottom silica dishes

Beakers

Pipette

Thimbles

Conical flasks

Muffle furnace

Digestion block ((Kjeldatherm (England), serial number 444098)

Galvanometer (cam metric limited (England), serial number 8062-5806)

Ballistic bomb calorimeter (Gallenkamp (England), cat number 19/ID6790)

Atomic Absorption Spectrometer (AAS) (United States USA, serial number 1058)

Spectrometer 20^{+}D (Milton Roy (United State UAS, serial number 37E7205036) .

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Data Presentation and Analysis

The nutritional values of rice are presented in Table 4.1. Each parameter is a mean of three replicate determinations.

Table 4.1: Proximate Compositions of Unparboiled Rice and Rice Parboiled at Different Temperatures

Parameter		Parboiled Rice		
	Unparboiled Rice	80°C	100°C	120°C
Moisture content (%)	17.00 ± 1.00	12.00 ± 2.00	13.04 ± 1.52	13.24 ± 0.80
Ash (%)	1.50 ± 0.10	2.32 ± 0.73	2.39 ± 0.67	2.08 ± 1.18
Crude fibre (%)	9.33 ± 0.02	4.89 ± 1.54	4.89 ± 1.65	4.89 ± 1.68
Crude protein (%)	6.61 ± 0.03	5.29 ± 1.35	6.33 ± 0.48	4.25 ± 1.91
Ether extract (%)	2.00 ± 0.20	1.83 ± 1.04	2.17 ± 0.76	2.50 ± 0.50
Carbohydrate (%)	80.56 ± 0.02	85.91 ± 1.34	84.19 ± 2.90	85.63 ± 2.23
Energy value (J/g)	61.92 ± 0.02	63.46 ± 1.47	65.27 ± 1.51	55.93 ± 11.12
Iron, Fe (ppm)	1.750 ± 0.04	0.933 ± 0.431	1.135 ± 0.140	1.493 ± 0.178
Zinc, Zn (ppm)	1.625 ± 0.003	1.600 ± 0.283	0.725 ± 0.389	1.080 ± 0.636
Calcium, Ca (ppm)	3.287 ± 0.003	1.612 ± 0.112	3.419 ± 1.721	3.680 ± 2.524
Vitamin A (mg/100g)	0.0031 ± 0.0002	0.0019 ± 0.0008	0.0013 ± 0.0009	0.00053 ± 0.0005
Vitamin C (mg/100g)	0.80 ± 0.02	0.40 ± 0.10	0.30 ± 0.10	0.29 ± 0.09

Values are means of triplicate determinations ± SD (standard deviations)

Table 4.2 is used to determine significant differences between means of proximate compositions for the unparboiled rice and parboiled rice at different temperatures.

Table 4.2: Determination of Significant Differences between Means of Proximate Compositions for Unparboiled and Parboiled Rice

Parameter		*Parboiled Rice*			
	Unparboiled Rice	80°C	100°C	120°C	P-values at 5% level of significance
Moisture content (%)	17.00b	12.00a	13.04a	13.24a	0.314**
Ash (%)	1.50a	2.32ab	2.39 b	2.08 ab	0.473**
Crude fibre (%)	9.33b	4.89a	4.89a	4.89a	0.473**
Crude protein (%)	6.61b	5.29ab	6.33ab	4.25a	1.00**
Ether extract (%)	2.00a	1.83a	2.17a	2.50a	0.116**
Carbohydrate (%)	80.56a	85.91b	84.19b	85.63b	0.438**
Energy value (J/g)	61.92a	63.46a	65.27a	55.93a	0.100**
Iron, Fe (ppm)	1.750a	0.933a	1.135a	1.493a	0.371**
Zinc, Zn (ppm)	1.625a	1.600a	0.725a	1.080a	0.230**
Calcium, Ca (ppm)	3.287a	1.612a	3.419a	3.680a	0.230**
Vitamin A (mg/100g)	0.0031d	0.0019c	0.0013b	0.00053b	0.001*
Vitamin C (mg/100g)	0.80d	0.40c	0.30b	0.29a	0.001*

Values are means of triplicate determinations, n = 3

**No significant difference (P>0.05)

*Significant difference (P<0.05)

H_0: There is no significant difference in the means.

Ha: There is significant difference in the means

a. =Residue obtained after extraction of fat with Osborne classical solvent

b. = Mean of three replicates

c. = For rice, whole meal fat are positively correlated (P=0.05)

d. =Vitamins A and C variations in the results of the present work

Note: If $P \leq 0.05$ accept H_a and conclude that the means are significantly different from each other.

If $P > 0.05$ accept H_o and conclude that there is no significant difference in the mean values of nutritional components.

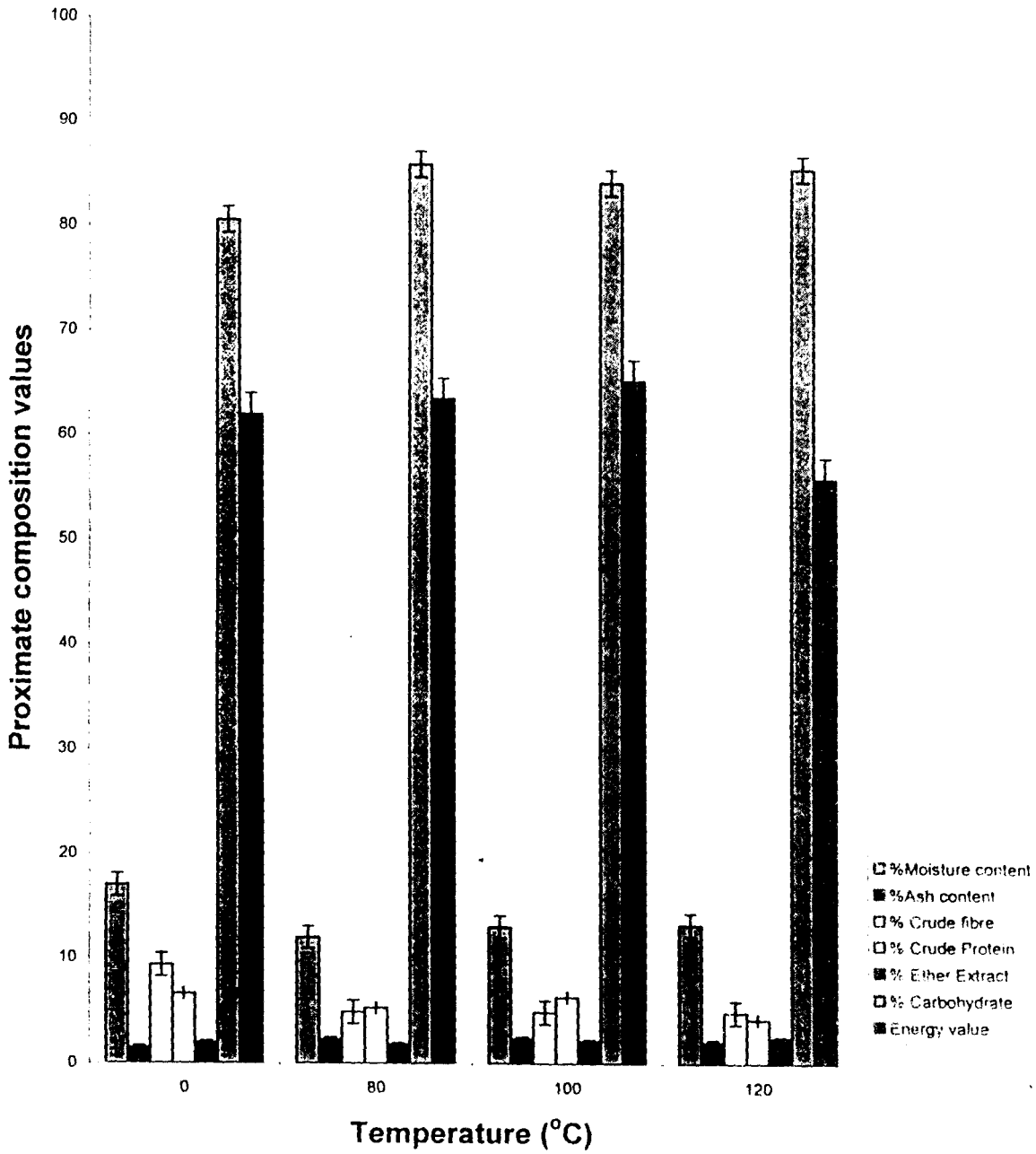

Figure 1: Relationship between proximate composition of unparboiled and parboiled rice and temperature

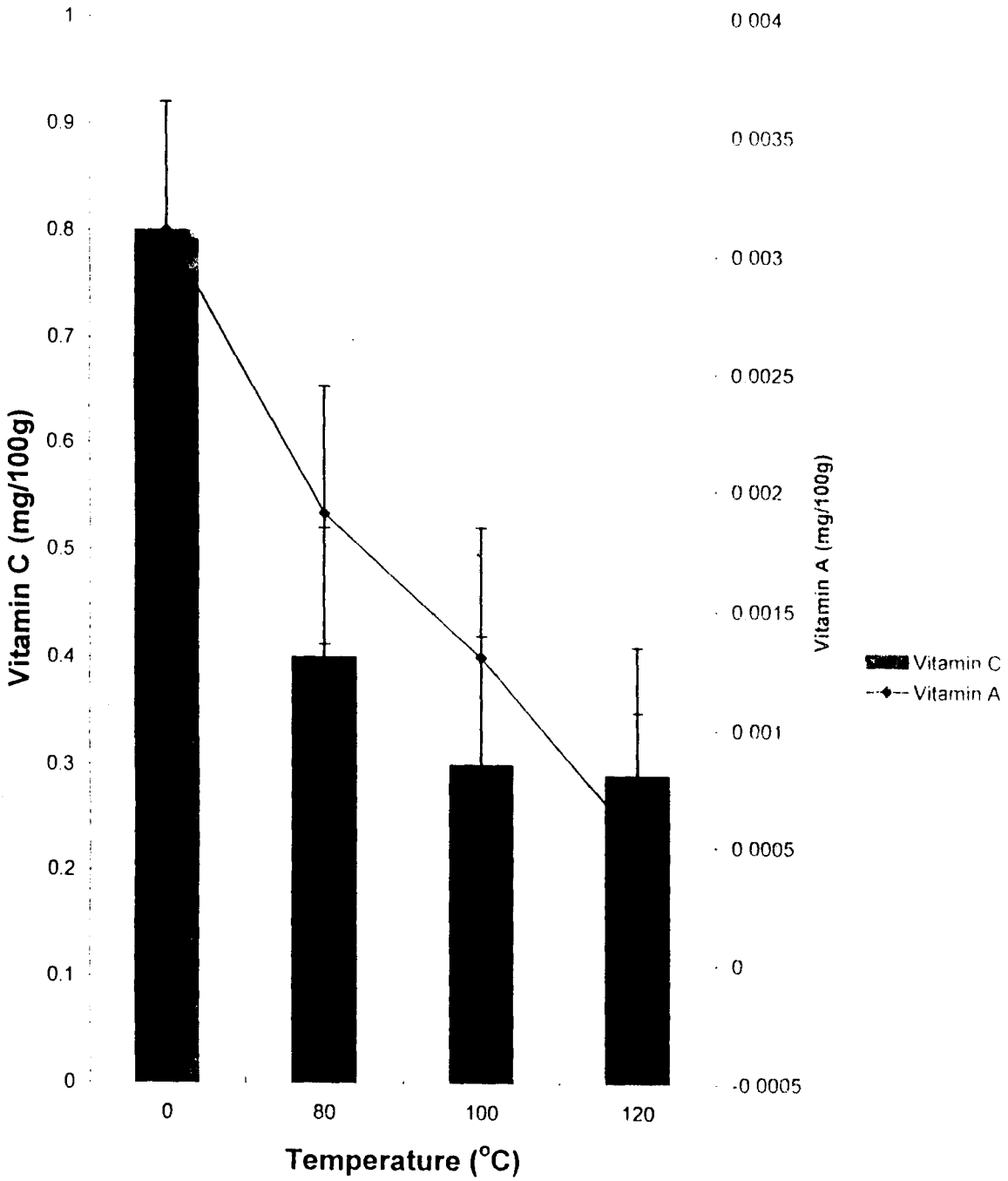

Figure 2: Vitamin A and C content in Raw and parboiled rice

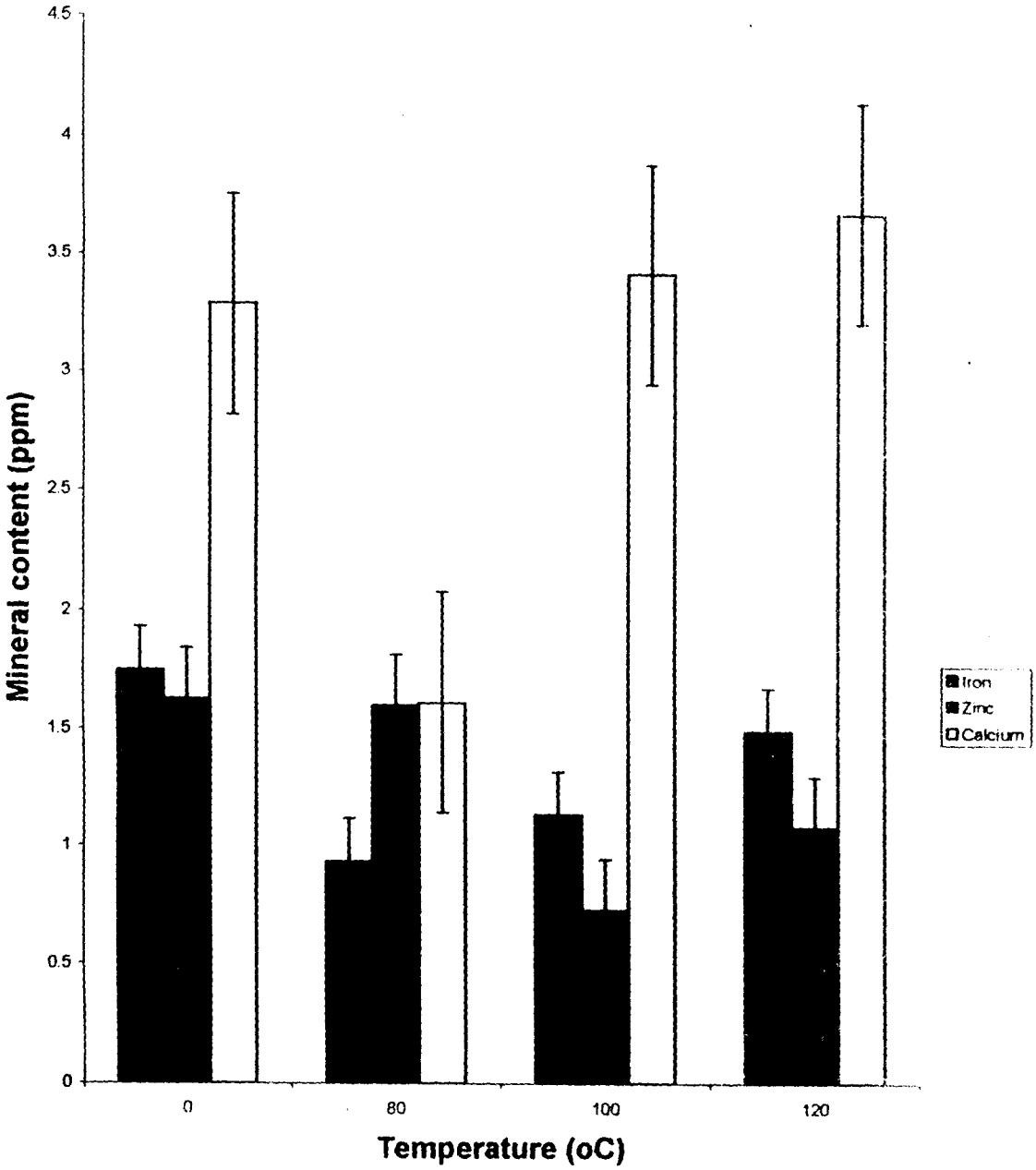

Figure 3: Mineral Contents of parboiled and unparboiled rice at different temperatures

2 Discussion of Results

The overall results obtained for the parameters in this study are further explained using the tistical package, SPSS 11.0.

A significant difference was obtained for temperature, $P<0.05$. The raw sample (0.80) has gnificantly high vitamin C content than sample treated at temperatures at 80^0C (1.1767), 100^0C .7833) and 120^0C (0.520). Samples parboiled at 80^0C has significantly high vitamin C content an those parboiled at 100^0C and 120^0C as in figure 2 above. Also sample parboiled at 100^0C ows a slight difference in vitamin C content than sample parboiled at 120^0C as demonstrated in gure 2 above.

A significant main effects was obtained for temperature, $P<0.05$. The raw sample 0.1500) has significantly high vitamin A content than sample treated at temperatures at 80^0C 2.1333), 100^0C (8.2333) and 120^0C (3.4667). Samples parboiled at 80^0C has significantly high tamin A content than those parboiled at 100^0C and 120^0C .Also sample parboiled at 100^0C has gnificantly high vitamin A content than sample parboiled at 120^0C as indicated in figure 2.

Also, a significant main effects was recorded for temperature, $P<0.05$. The raw sample 4.8000) has significantly high energy value than the sample treated at temperature of 120^0C 3.3667) while temperature treated at 80^0C (15.1667) and 100^0C (15.6000) are higher than the value. Samples parboiled at 100^0C has significantly high energy value than those parboiled at C and 120^0C .Also sample parboiled at 100^0C has significantly high energy value than ple parboiled at 120^0C as illustrated in figure 1 above.

A significant main effects was obtained for temperature, $P<0.05$. The raw sample 370) has significantly high calcium content than sample treated at temperatures at 80^0C

(2.9677) but sample treated at raw stage are lower compared to sample treated at 100^{0}C (4.7093) and 120^{0}C (15.7873). Samples parboiled at 80^{0}C has significantly lower calcium content than those parboiled at 100^{0}C and 120^{0}C .Also sample parboiled at 100^{0}C has significantly lower calcium content than sample parboiled at 120^{0}C as shown in figure 3.

Associati of Official Analytical Chemist, official method was used for the etermination of moisture content, ash, protein, carbohydrate and crude fibre.

The parboiled rice kernel became translucent and glassy unlike the non-parboiled kernel hat is white and opaque. This occurrence is likely due to the to gelatinization of starch and isruption of protein bodies which expanded and occupied all the air spaces in the endosperm luring parboiling as reported by Rhagavendra, Rao and Juliano (1970). The opaque and white elly caused by loose arrangement of starch granules therefore disappeared making the kernel ranslucent.

The rice samples are long grain type according Webb and Sterner (1972) method of rain classification. However the parboiled rice kernel has a shorter length and broader breadth hen compared with the non-parboiled rice sample. This is in agreement with the result of haghavendra and Juliano (1970) that parboiled rice expanded less in length but more in eadth.

The degree of parboiling which is a measure of severity of the heat treatment the rice was lected to can be said to be higher in the white parboiled samples than the brown parboiled ples. This is measured by the percentage of the rice grain that disintegrated in dilute alkali he greater the disintegration the higher the degree of parboiling. This may also explain the n why the percentage breakage in the brown rice variety (parboiled) is higher than that of hite variety. It may be due to incomplete parboiling which results in a "white belly" kernel.

which causes increase breakage during milling. The percentage breakage in the parboiled rice samples is lower than that of the non-parboiled samples. This is as a result of hardening of the grains after parboiling which reduces the breakage and the milling quality.

The cooking time of the parboiled rice samples was between 10-50min. The variety of rice used for this study has high cooking time when compared with 10-25min reported by Adeyemi *et al* (1986) and Rhagavendra and Juliano (1970). The longer cooking time of the parboiled rice samples compared to the non parboiled samples may be due to the strong cohesion between the endosperm cells which are tightly packed. This makes the starch grains to hydrate at a slower rate, which leads to a decrease in water penetration into the grains, hence a longer cooking time. Juliano and Perez (1986) found that the higher the protein content of rice, the higher the gelatinization temperature hence, cooking time. This is ostensibly due the hydrophobic nature of proteins, which act as a barrier to inward diffusion of water into the cooking grain, and hence raise the gelatinization temperature. The water absorption of the parboiled samples were higher than that of the non-parboiled samples, while the water absorption of the white variety was higher than that of the brown variety. Mustapha (1979) in his study on physico- chemical qualities of rice stated that parboiled rice has higher water absorption, which may be as a result the steaming pressure during parboiling which in turn affects starch gelatinization.

There is decrease in protein content of the parboiled rice samples (rice) compared to the ıon-parboiled samples(6.61%), which may be due to leaching of protein substances during ɔaking and rupturing that occurs in the molecules due to steaming. The process of parboiling akes the protein bodies to sink into the compact mass of gelatinized starch grains, making it less tractable hence a decrease in the protein content. There is no soaking or steaming process for

non-parboiled samples though little loss in protein content may occur during milling, but this incomparable to what happens during parboiling, hence it has higher protein content than the rboiled samples

The parboiled rice samples also have higher fat content than the non-parboiled samples. is may be explained in terms of leaching and rupturing of the oil globules that occur due to crease in temperature and steaming pressure that occurs during the parboiling process. This sult shows significant difference when compared to the results obtained for fat in parboiled rice Rhagavendra and Juliano in 1970.

The carbohydrate content of the parboiled rice samples was higher than that of the non-rboiled samples. This may be as a result of starch gelatinization, which makes the grain to pand, thus filling up the surrounding air spaces. Starch re-association, increase in some rbohydrate components like reducing sugars, change in molecular size and partial dextrinisation starch which have been known to occur during parboiling. (Rhaghavendra and Juliano, 1970).

There was slight increase in vitamin A content of the parboiled rice samples. This agreed th the findings of Gariboldi, (1974) that it may be due to the fact that during steaming, water uble vitamins are spread throughout the grain, thus altering their distribution and ıcentration.

Temperature and time affect vitamin C content in rice. The higher the temperature of oiling rice the iower the vitamin C content. Also the more the length of time the lower the nin C content of rice.

The results obtained for moisture content for raw rice shows a slight reduction in the ure content of rice when compared to the values obtained for parboiled rice. This result is in nent with Adeyemi who demonstrated that the moisture content of rice result to a slight

crease under gradual increase in temperature in 1986.

Ash content of rice (raw) indicates that temperature has significant influence on the ailable composition of ash content in rice. At the initial stage of parboiling, the result shows a adual increase in the ash content of rice, as the temperature increases and the overall values tained can be compared to the results obtained for the same parameter by Raghavendra and liano (1970) who shows the effects of some physico-chemical properties on parboiling rice.

Crude fibre results indicate that temperature has no significant difference on the fibre ntent of parboiled rice. The results show a constant and stable value for crude fibre as the mperature increases.

Results obtained for the mineral compositions (Fe, Zn and Ca) of rice indicate slight ariations in their availability at different temperature range. Iron shows almost continuous values r its constituent throughout the experimental process except the slight reduction at eighty degree mperature. The same situation can also be observed for Zinc and Calcium at temperatures of undred degree and eighty degree respectively.

On the other hand, the results obtained for energy values indicate that at higher nperatures, the energy value of rice decreases. This is a phenomenon that is common with most in products as shown by the United States Department of Agriculture (U.S.D.A) in 1999.

CHAPTER FIVE

0 CONCLUSION AND RECOMMENDATIONS

1 Conclusion

From the results obtained in this study, it can be concluded that parboiling as a unit peration in rice processing affects both the physical and chemical properties of the grain. It nproves milling and cooking qualities of the rice grains in a positive manner which has been und to influence consumers demand and acceptability. The slight reduction in the nutritional ntents of rice may attributed to the fact that most Agricultural products are organic in nature nd tend to react quickly to any environmental influence through its numerous parameters such as mperature and relative humidity.

2 Recommendations:

uring the introductory part of this study, it was stated that rice is one staple food feeding illions of families all over the world. This implies that proper attention must be given to the rop to ensure continuity in its production. In view of this, it is recommended that

Other varieties of rice should be used for the same experimental process in order to determine y variations.

Since parboiling of rice at higher temperature leads to decrease in the available protein tent in rice, the parboiling operation should be carried out under relatively low temperature.

Funding was one of the most militating factors towards the success of this study. In equent studies of this nature, fund should be made available to aid the researcher in areas of rial procurement needed for the study. This is one area where ADP plays an important role.

REFERENCES

AOAC. (1980). Association of Official Analytical Chemist. In Official Methods

Anderson M. (1980). Recommended Dietry Allowances. 9th edition, National Academy of Sciences, Washington DC, USA. pp. 20 – 28

Ali N. and Ojha. T.P.(1976): Parboiling. Rice post Harvest Technology. Ed Araullo, E. U. IDRC. Canada 163-204.

Adeyemi, I. A., Fagade, S.O., and Ayotade, K. A. (1986). Some physicochemical and cooking qualities of Nigeria rice varieties. Nigerian food journal. Vol.4, (1) 26-33

Banjong,O., Viriyapanich, T. and Chitchang, U. (1995). *Handbook for dietary evaluation* Institute of Nutrition, Mahidol University, Thailand. pp.20 – 22

Bhattacharya, K.R. (1979): Test for parboiling rice. Proceedings of Workshop on Chemistry Aspects of Rice Grain Quality. Los Banos, Philippines. IRRI, 363-373

"Carbohydrate." *Microsoft® Encarta®* 2006 [CD]. Redmond, WA: Microsoft Corporation, 2005

Chen, H., Siebenmorgn, T. and Griffin, K. (1998). Quality Chareacteristics of Long – Grain Rice Milled in Two Commercial Systems *Cereal Chemistry*, 4 (75): 560 - 565

De Lucia, M. and Assennato, D. 1994. Agricultural engineering in development post – harvest operation and management of foodgrain. FAO Agricultural Service Bulletin No. 93, Rome FAO.

Ezeike. G. O. I. (1987): Energy consumption in rice processing operating in Nigeria:

Selected case. AMA. 18(1). 33-40.

FAO. (1998). Physical Activity: Impact of Protein and Amino Metabolism and Implication for Nutritional Requirements. World Health Organization (WHO) Tech. Rept. Ser No 522, Geneva: World Health Organization.

FAO. (2000).FAO Rice Imformation, Volume 2. Food and Agricultural Organization of the United Nations, Rome Italy. pp. 5 – 8.

FAO. (1994). African experience in the improvement of post-harvest technique. Synthesis based on the Workshop held in Accra Ghana, 4-8 July 1994 Agricultural Support System Division, Rome

FAOSTAT. (2001). FAO Statistical Databases. Available online at http://apps.fao.org/. Accessed May 2, 2001.

Grist, D.H. (1986). Rice (6th edition).Longman Singapore Publishers, Singapore. pp 599.

Gariboldi, F. (1973): Rice testing method and equipment. Food and Agriculture Industries services. Agricultural Service Division, FAO, Rome, Italy.

Jackson, M.T. (1995). Protecting the Heritage of Rice Biodiversity. Geojournal, 35:267-274.

Juliano, B. O. (1984): Head, Cereal Chemistry Department: IRRI, Los Banos, Philippines.

Jones, J.W. (1946): Effect of parboiling and related treatment on the milling, nutritional and cooking quality of rice. USDA Circ., 752

Juliano, B.O. and Perez, C.M. (1986). Studies on cooking property of tropically milled rice. J. Food Chem.20: 97-105.

Lin, Y.E. (1992). Parboiled rice product and method of making same-Patent Retrieved from (http: // www.freepatentsonline. com./5316783. html).

Mustapha, F.O. (1979). The effect of parboiling on some physico-chemical properties of some local rice varieties. B.Sc. Thesis, University of Ife, pg. 22-27.

National Research Council (NRC) (1996). Lost Crop of Africa, Vol. 1, Grain National Academic Press,Washington D. C., pp. 3 – 6, 59 – 72, 251 – 272,360.

Pandya, AC. (1977): Terminology of processing and production of rice. Rice process Eng'g Centre. India Institute of Techn, Kharagpur. India.

Pokin, B., Keyou, G., Fengying, Z., Guo, X., Haijiang, M. and Zohoori, N. 1993. The nutrition transition in china: a cross-sectional analysis. European J. of Clinical Nutrition, 47:333-346.

Raghavendra Rao, S.N. and Juliano, B.O. (1970). Effect of parboiling on some physico-chemical properties of rice. J. Agric Food chem. 18: 289-294.

Saunders, R. and Betschart, A. 1979. In Inlglett, G.E. and Charalambous, G. eds. Tropical foods: chemistry and nutrition, p. 191-216. NY, USA, Academic Press

USDA. (1999). United States Department of Agriculture, Database for Standard Reference , Release 13. Nutrient Data Laboratory Home Page, http://www.nal.usda.gov/fnic/foodcomp

UNICEF (2001). State of the world's children. United Nations Children's Fund.

Wimberly, J.E. (1983): Paddy rice post-harvest industry in developing Countries. IRRI. Philippines.

Webb, B.D.and Stermer, R.A. (1972). Criteria of rice quality. In: Rice: Chemistry and

Technology. (Edited by Houston D.F.) Amer. Ass. Cereal Chem. St. Paul MN.

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APPENDICES

Appendix A

AOAC (1980) Guidelines for Determining Nutritional Parameters

Prior to each analysis, a representative sample of the material should be carefully made: such methods vary with the type of food materials. Determinations are usually made on dry samples except moistures determination; result obtained may be reported in terms of dry or wet weight of the samples. The dried material is ground in a mortar into powdered form. often necessary to pass through sieve of particular mesh size, and then stored in dry containers. Most food such as meat, fish etc should be minced and then mixed in a mortar. The process should be repeated before analysis. Wet foods can be bost processed in a high-speed blender. Average of several determinations made on random samples from the foodstuff container makes result valid. The following are some of the major determinations on proximate composition.

1. Moisture: Dry a metallic dish in an oven at 80°C for 20minutes, cool in a desicator and weigh (W_1). Take few grams of the sample into the dish and take weight (W_2). The dish with sample is then dried in an oven at 80°C usually for 24hours (better until constant weight is reached), and is quickly transferred to a desicator to cool. Weigh quickly with minimum exposure to atmosphere (W_3). The loss in weight of the sample during drying is the moisture content. (%) =

$$\left(\frac{W_2 - W_1}{W_3 - W_1}\right) \times \frac{100}{1}$$

2. Ash and Organic matter: The ash is an analytical term for the inorganic residue that remains after the organic matter has been burnt away. The ash is not usually the same as the inorganic matter present in the original food since there may be losses due to the volatilization or chemical interaction between the constituents. The value is useful in assessing the quality or grading certain edible materials.

Hold a clean, flat bottomed silica dish (about 7cm diameter) in a hot Bunsen-burner flame for one minute, transfer it to a desiccator, then cool and weigh (W_1). Take about 5g of the food sample into the dish and weigh (W_2) again, so that the weight of the sample (W_2-W_1) may be found by difference. Heat the silica dish containing the sample gently on a Bunsen burner in a fume cupboard until smoking ceases, then transfer to a Muffle furnace heated to about 5oo°C. Continue heating until all the carbon has burnt away (usually 24 - 48 hours). Switch the furnace off, take out the silica dish, immediately covered, and place inside a desicator. cool, and weigh (W_3). Calculate ash content and find ash (%)

$$\text{Ash (\%)} = \left(\frac{W_3 - W_1}{W_2 - W_1}\right) \times \frac{100}{1}$$

The portion of the sample, which burnt off is organic matter.

$$\text{Organic matter (\%)} = \left(\frac{W_2 - W_3}{W_2 - W_1}\right) \times \frac{100}{1}$$

3. Lipid: The lipid content of biological materials can be estimated by directly extracting the dry material exhaustively using a suitable lipid solvent e.g. petroleum (40°-60°C), diethylether etc in a convenient continuous extractor, such as Soxhlet, Bolton or bailey – walker type. Direct extraction gives the proportion of free fat.

About 5g of the sample powder is taken into a thimble of known weight (W_1). They together weigh W_2. The thimble with sample is placed inside a Soxhlet extractor 300ml of acetonethanol mixture (1:1) is poured into a 500ml round bottom flask. The Soxhlet extractor with the thimble plus sample is filled into the flask, which is sited in electrically connected heating mettle. the mettle, is switched on and the heat increased carefully and slowly until the solvent boils. Condensed solvent vapour collects in the thimble and dissolves the lipid in the sample. The olvent with dissolved lipid will continuously run back into the flask). The heating and so the

extraction process is continued for about 24 hours when the thimble with contents is removed, dried in an oven at 50°C for 24 hours, cooled in a desiccator and weighed (W_3).

$$\text{Calculated lipid (\%)} = \left(\frac{W_2 - W_3}{W_2 - W_1}\right) \times \frac{100}{1}$$

The solvent is distilled off to about 20ml; the lipid in solvent is quantitatively trasfered on to an evaporating dish, cooled, dried in a desicator. The lipid thus recovered may be weighed and lipid (%) calculated.

4. Nitrogen and crude protein: The reference 'Kjeldahl protein determines the total nitrogenous matter which includes non-proteins as well. Most proteins contain about 16% nitrogen. Total nitrogen, estimated by the Kjeldahl method is multiplied by 6.35 to express the average crude protein, for milk and egg this factor is 6.38 and 6.68 respectively. K_2S raise boiling point of digestion mixtures and copper sulphate accelerate the chemical changes. Nitrates and nitrites are not determined by this procedure. Kjeldahl method is a volumetric method producing $(NH_4)_2SO_4$ by acid digestion of sample. From alkaline digest, ammonia is distilled off, collected as Boric acid complex and estimated.

There are other methods nitrogen estimates also.

Kjeldahl method for nitrogen estimation K_2SO_4, $CuSO_4$

Reagents:

(a) Mixed catalyt, 160g anhydrous K_2SO_4, 10g $CuSO_4 + 5H_2O$, 3g selenium powder are mixed well in a mortar and stored dry in a container.

(b) Sulphuric acid, 98g Conc.

(c) Sodium hydroxide 40% w/v

(d) Boric acid

(e) Hydrochloric acid, standard, N/70,

Procedure:

(a) Weigh out accurately about 250mg sample into clean, dry 100ml Kjeldahl flak, and add about 1g-mixed catalyst. Add 6ml Conc. H_2SO_4 and few chips of pumic stone or glass beads.

(b) Carefully digest over an electric heater in the hood (initially with low flame) until frothing subsides and then at higher temperature until content are clear greenish continue digestion for further 60minutes.

(c) Put off heat, allow flask to cool and add 15ml water, transfer contents quantitatively to a 50ml volumetric flask using distilled water, transfer to rinse out, but leaving the pumic stones behind. Make volume with distilled water and mix well

(d) Transfer with pipette 5ml of the digest into the Makhamsonimicro nitrogen still, add 10ml of sodium hydroxide solution to the digest. Steam distilled ammonia liberated into the 10ml hydrochloric acid solution containing 2drops of indicator taken in the conical flask. The indicator will turn green and continue distillation for 2 more minutes.

(e) Remove distillate and titrate with the standard hydrochloric acid, the end point being reached when the amount of acid from green to grey to definite point. Note down the amount of acid consumed.

(f) A blank is run through the whole procedure and burette reading is subtracted from that in (e) above to get a corrected titre value of standard hydrochloric acid.

Calculation: Nitrogen (%) in the sample = $\frac{\text{corrected titre (ml) x 14 x 5 x 100}}{\text{1000 x 70 x weight of sample (g)}}$

$= \frac{\text{corrected titre (ml)}}{\text{10 x weight of sample (g)}}$

Crude protein content (%) = 6.25 x Nitrogen (%)

5. Content of Carbohydrates and nucleic acid: If the total of protein and lipid content is

subtracted from organic matter, the remaining accounts for carbohydrate and nucleic acid as organic matter (%) – (protein (%) + lipid (%)).

6. Determination of Iron Content: The buck scientific Atomic Absorption spectrophotometer model 210 VAP was used to analyze the iron.

The samples were aspirated into the burning chamber through the capillary tubing. Oxygen/Acetylene gases were used to ignite the samples, to excite the atoms to higher energy levels. The excited metallic atoms absorbed ultraviolet light at a wavelength's characteristics of each metal under investigation from the hollow cathode lamp of that metal. The absorption of each metal was recorded accordingly. From the working curve of standard solutions prepared, the concentration of each metal was determined.

7. Determination of Calcium Content: The buck scientific Atomic Absorption spectrophotometer model 210 VAP was used to analyze the calcium.

The samples were aspirated into the burning chamber through the capillary tubing. Oxygen/Acetylene gases were used to ignite the samples, to excite the atoms to higher energy levels. The excited metallic atoms absorbed ultraviolet light at a wavelength's characteristics of each metal under investigation from the hollow cathode lamp of that metal. The absorption of each metal was recorded accordingly. From the working curve of standard solutions prepared, the concentration of each metal was determined.

8. Determination of Zinc Content: The buck scientific Atomic Absorption spectrophotometer model 210 VAP was used to analyze the zinc.

The samples were aspirated into the burning chamber through the capillary tubing. Oxygen/Acetylene gases were used to ignite the samples, to excite the atoms to higher energy levels. The excited metallic atoms absorbed ultraviolet light at a wavelength's characteristics of

each metal under investigation from the hollow cathode lamp of that metal. The absorption of each metal was recorded accordingly. From the working curve of standard solutions prepared, the concentration of each metal was determined.

9. Determination of Calories Content

Procedure:

1. 10g of the sample was put into the bombcase
2. The galvanometer reading was adjusted to zero
3. Heat was supplied to the upper part of the bombcase using the oxygen gas
4. It warmed rapidly (50 seconds) to a high temperature of about 70°C and the reading on the galvanometer was taken immediately as the temperature began to drop rapidly.

$$\frac{C_B}{C_S} = \frac{Q_B}{Q_S}$$

Where C_B = caloric value, dry pure benzoic acid

Q_B = peak galvanometer deflection per gram of benzoic acid

Q_S = peak galvanometer deflection per gram of test sample

C_S = caloric value of sample

10. Determination of vitamin A Content

Procedure

1. Weigh the sample and mince into fairly fine pieces.
2. Weigh out a 1g aliquot and transfer to a mortar.
3. Add 3-5g Na2So4.
4. Grind the tissue with a pestle until a free-flowing powder is obtained.
5. Transfer powder to a 250-ml conical flask.
6. Add 50ml petroleum ether (b.p 40-60 c0) and cover flask with clingfil.

7. Shake flask for 3 minutes (this extracts the vitamin A) and allow to stand in the dark for 10 minutes.

8. During 10-minutes interval, prepare trifluoroacetic acid reagent (TFAR) pipette into a test tube 5ml chloroform , followed by 2.5ml trifluoroacetic acid. Stopper the tube and mix. (DO THIS IN THE FUME CUPBOARD AND USE A PIPETTE-FILLER).

9. Set spectrophotometer to zero absorbance at 620nm with a cuvette containing 0.1ml chloroform + 0.1ml acetic anhydride +1.0ml TFAR.

10. Pipette 0.5ml of pet ether-extract (from step 7) into a cuvette. and evaporate by means of a gentle current of air.

11. Redissolve residue immediately in 0.1ml chloroform + 0.1ml acetic anhydride.

12. Add 1.0ml TFAR, transfer cuvette to spectrophotometer, and read the absorbance at 620nm exactly 30 seconds after addition of reagent.(This is best done with persons working together- one with an eye on the clock, the other adding reagent and taking readings).

11. Determination of Vitamin C Content: Procedures for the determination of Vitamin.C into 5ml of sample add 2ml glacial acetic acid and 1ml of chloroform (if the sample is coloured). Titrate with a solution of 2,6-chlolrphenol-indo-phenol in the burette until permanent point pink colour is obtained, with titre T is then recorded. Repeat the titration with 5ml distilled water for he blank (Br) and 5ml of std ascorbic acid solution (st). The Vitamin C ccatent of the sample vas thus calculated (mg/100g)