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THE MICROBIAL ENRICHMENT OF RICE AND SWEET POTATOES ON THEIR NUTRITIONAL STATUS

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ABSTRACT

The objective of this study was to assess the effect of fermentation on the proximate composition of boiled rice (*Oryza sativa*) and sweet potatoes (*Ipomoea batatas)* with the aim of improving their nutritional qualities. Boiled samples of unfermented and fermented polished rice and sweet potatoes were fermented to determine their proximate composition. The fermentation resulted in decrease in moisture content (6.66%-0.00% for rice and 10.00%-5.00% for sweet potatoes). The result also revealed an increase in crude protein (4.62%-5.00% for rice and 1.53%-49.00% for sweet potatoes). Crude ash was 5.00% for rice and sweet potatoes). However carbohydrate content was lower in sweet potatoes (85.9%-38.51%) and slightly decreased in rice (87.87%-85.32%). This shows that fermented rice could be a good source of energy giving food while fermented sweet potatoes could be a good source of protein when added in staple diet. Both samples recorded a drop in their pH after fermentation, with temperature being steady throughout the fermentation period.

Key Words: *Microbial Enrichment•Fermentation•Yeast• Proximate composition*.

INTRODUCTION

Food is one of the basic necessities of life. The need for food begins with the beginning of life, for it must provide the essential components of life and growth (Amadi *et al*., 2011). Some of these food`s nutritional benefits are best derived in their fermented state. Fermented foods are undoubtedly an essential part of diets in all regions of the world. Fermented foods are food substrates that are invaded or overgrown by edible microorganisms whose enzymes particularly amylases, proteases and lipases hydrolyse the polysaccharides, protein and lipids to non-toxic products with flavours, aromas and textures pleasant and attractive to human consumer (N`Guessan *et al*., 2008). Several traditional fermented products exist in different African countries and include non-alcoholic beverages, alcoholic beverages, bread, pancakes, porridges, cheeses as well as cereal foods. They are prepared from both plant and animal materials using processes in which microorganisms by virtue of their metabolic activities, play an active role in the physical, nutritional and organoleptic modification of the starting material. These microorganisms come from microbial populations associated with the raw materials, equipment and local environments or a residue from a previous fermentation batch (N`Guessan *et al*., 2008). Fermentation is one of the oldest and most widespread methods of preserving and improving food quality. Practically all nations have some traditional type of fermented product made by the action of microorganisms (FAO 1998). Fermentation is could be regarded as one of the economical methods of producing and preserving food for human consumption. Apart from increasing the shelf life, and a reduction in the anti-nutritional factors (Reddy and Pearson 1999, Achi and Okereka 1999), fermentation markedly improves the digestibility, nutritive value and flavours of food. Potato is believed to be a native of South America because the greatest diversity of wild varieties of the plant exists there. The introduction of potato to Europe, Africa, Asia and even North America occurred in more recent time (Ogunjobi et al., 2005). Today, potato is grown in nearly all parts of the tropical and subtropical world and in warmer areas of the temperate regions. It has remained for centuries an important staple for many tropical communities (Onweume, 1978). It has been reported that potato starch is a large-grained starch containing 25% amylase and 73% amylopectin and high phosphate content(anon. 1985). The most common types of potato are red and white. From a nutritional standpoint, potatoes were superior to preexisting staple crops because they provided more vitamins and nutrients and they provided a greater supply of calories. Because potatoes contain nearly all important vitamins and nutrients, they support life better than any other crop when eaten as the sole article of diet (Davidson *et al*. 1975; Reader 2008). According to the U.S. Department of Agriculture (2007), a medium potato (150 grams/5.3 ounces) with the skin provides 29.55milligrams of vitamin (45 percent of the daily value [DV]). This is important since other staple crops such as wheat, oats, barley, rice, and maize do not contain any vitamin C, a necessary deterrent for scurvy. For much of the Old World, the potato provided the only source of vitamin and protection against scurvy. Rice (*Oryza sativa*) is the basic diet of more than half of the world`s population and is widely cultivated in the tropical and temperate regions (Tsunoda *et al*., 1984). More than half of the four billion people on the earth depend on this food for their basic diet. It is unique in its adaptive nature to hot and humid environments. Rice meals vary from place to place. In some countries it is boiled or steamed and eaten with pulses, vegetables, fish and meat or with stew or sauce. Ground rice or rice flour is commonly used in confectioneries and fermented rice is added as adjuncts in making wines, beers and spirits (Gibbon and Adam, 1985). Rice bran is a valuable livestock feed although rice straw, which is of lower nutritional value than bran is widely used (Gibbon and Adam, 1985).

Almost without exception fermented foods were discovered before mankind had knowledge of microorganisms other than as witness to the effect of their activity. Fermentation is one of the oldest technologies used for food production and preservation (Holzapfel 2002; Motargeni; 2002). Many benefits are attributed to this technology. As reported by Mortojemi (2002) it preserves and enriches food, improves digestibility and enhances the taste and flavor of foods. Furthermore, fermentation has the potential of enhancing food safety by controlling the growth and multiplication of a number of pathogens in food. Similarly fermented foods play an important role in providing food security, enhancing livelihoods and improving the nutrition and social well being of millions of people around the world. A large proportion of Nigerian diets are made from fermentation processes. This study aims at investigating the development of some nutritive values and improving the desirability of fermented rice and sweet potatoes.

MATERIALS AND METHODS

Source and fermentation of Rice and Sweet Potatoes

The polished rice and sweet potatoes were purchased from the main market within Sokoto metropolis in Nigeria. 50g of the potatoes were washed, peeled and cut into slices. The polished rice was thoroughly washed and both samples were boiled separately for 30 minutes and allowed to cool. The samples were inoculated with 200g brewer's yeast (*Saccharomyces cerevisae*) in 2 litres aspirator flasks and allowed to undergo fermentation for 3days. The pH, total titrable acidity and proximate components of the rice and potato were determined.

Proximate Analysis

The AOAC (1990) methods were used in the determination of moisture content, crude protein, crude fat, total ash and crude fibre contents of each sample. Nitrogen free extract (NFE) was determined by difference between 100 and the sum of moisture, protein, fat and ash values. Crude protein content (% total Nitrogen ×6.25) was determined by the Kjedahl method using 2.0g of each sample according to Chang (2003). The fat content was determined by the soxhlet continuous solvent extraction gravimetric method with petroleum ether 60^0C -70^0C for 24hrs (Min and Boff, 2003). Ash content and moisture determination were according to AOAC (2000) while crude fibre was by the method of James (1995) where 2.0g of each sample was digested with H_2SO_4 and NaoH and the residue incinerated in a muffle furnace. All determinations were carried out in duplicates.

Statistical Analysis

Results were presented as mean±SD

RESULTS

Results of proximate composition of sweet potatoes and rice revealed that fermentation resulted in a marginal increase of total ash (2.50% - 5.00%), crude Protein (4.62% - 5.00%), Lipid (5.00% - 7.51%) and an increase in carbohydrate (85.31% to 87.88%) for fermented polished rice. The moisture content of the unfermented rice was higher than the fermented rice after fermentation (6.67% - 2.00% respectively) as shown in Table 1. Table 1 also shows the result of proximate composition of unfermented and fermented sweet potatoes where there was an increase in crude protein (1.5% - 49.00%) lipid content (10.00% - 15.00%) crude fibre (0.00% - 5.00%) respectively. However, there was a sharp decrease in carbohydrate from 85.92% - 38.50% as well as moisture content (10.00% - 5.00%). Figure I. Shows the pH observed during the fermentation of sweet potatoes and rice. The pH of both samples dropped after fermentation. Figure 2. Shows the temperature trend observed during fermentation with a fluctuation of 27^0C - 28^0C and 28^0C - 29^0C for both sweet potatoes and rice respectively. The mean colonial count of viable yeast cells during fermentation is as shown in table 2 where there was a corresponding increase in yeast cells until the last day of fermentation.

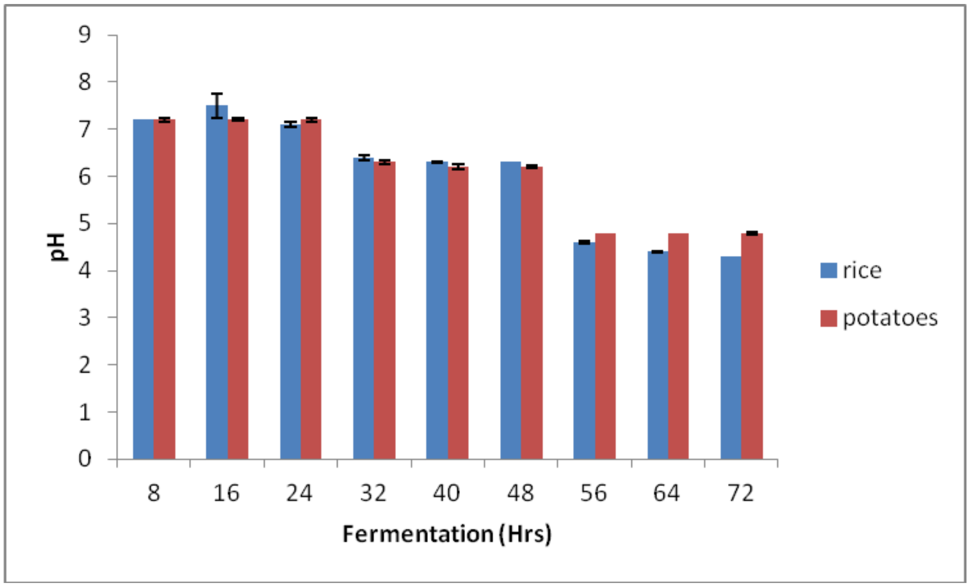

Figure 1: pH changes during three days fermentation of Sweet potatoes and Rice

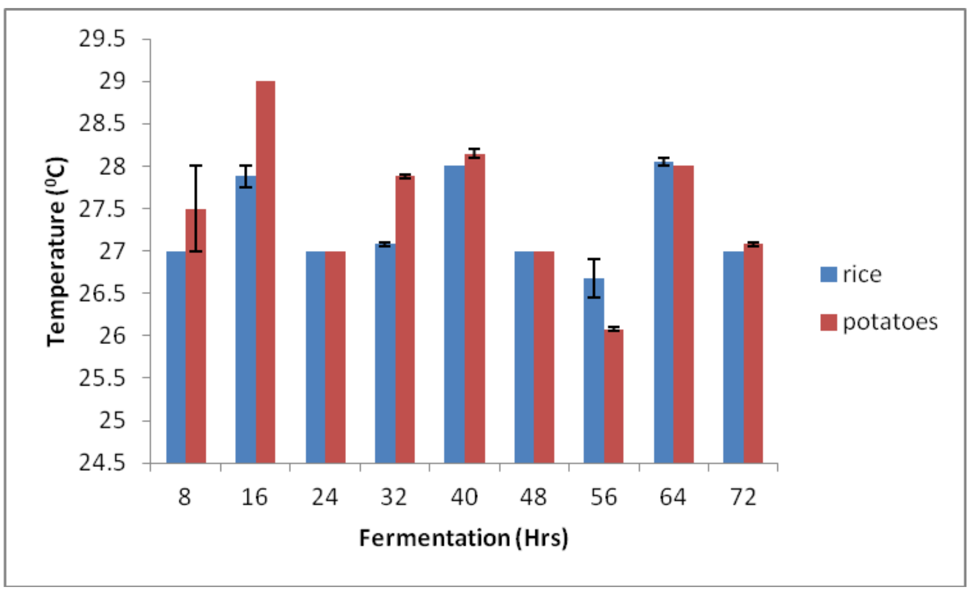

Figure 2: Temperature changes during three days fermentation of sweet potatoes and Rice

Table 1: Proximate Composition of unfermented and fermented Rice/Sweet potatoes (%)

	Rice		Sweet potato	
Parameters	Unfermented	Fermented	Unfermented	Fermented
Moisture	6.66 ± 0.01	2.00 ± 0.00	10.00 ± 0.00	5.00 ± 0.00
Protein	4.62 ± 0.01	5.00 ± 0.00	1.58 ± 0.01	49.00 ± 0.00
Fat	5.00 ± 0.00	7.51 ± 0.01	10.00 ± 0.00	13.01 ± 0.01
Fibre	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	5.00 ± 0.00
Ash	2.50 ± 0.00	0.50 ± 0.00	2.50 ± 0.00	5.00 ± 0.00
Carbohydrate	87. 87 ± 0.01	85.32 ± 0.01	85.9 ± 0.01	38.51± 0.01

Values are mean ± SD of duplicate determination

TABLE 2: Mean colony count of viable yeast cells during fermentation of Rice and Sweet Potatoes (cfu $\times 10^4$).

Time (hrs)	Rice	Sweet Potatoes
00	00	00
24	93	69
48	202	199
72	305	301

DISCUSSION

The role of fermentation in improving the nutritional composition of food has been reported in previous works of Odunfa (1985c). The results obtained in this study have shown that sweet potatoes and rice contain fermentable materials which were evident by rate of fermentation carried out by the yeast. Fermentation resulted in marginal increase in the proximate content of both samples. The increase in crude fat content of rice (5.00% - 7.50%) and sweet potatoes (10.00% - 13.00%) could be attributable to the fermentative activity of the yeast in ease of the release of fat from within the samples as also reported by (Appiah F and Ellis W.O 2011). Since the fermented rice and potatoes had lower moisture content (0.00% and 5.00% respectively) it is expected to have a good keeping quality. Higher moisture enhances spoilage through creating favourable conditions for microbial proliferation as well as enhances enzymatic deterioration. The protein content (49.00%) of the fermented sweet potatoes was higher than that of fermented rice (5.00%) in this study. Although not all tuber crops can be considered as good source of protein but reports have shown higher protein content in *Diascorea alata* (water yam) (Treche and Agbor –Egbe 1995) and cassava (Gomez and Valdivieso 1983). The fat content for both fermented sweet potatoes (13.0%) and rice (7.50%) showed that they were higher than the unfermented. Similar observation has been made by other authors in fermentation in cassava (a tuber crop as potatoes) (Oboh et al., 2003, Akindahusi et al., 1999). Fermentation did not significantly change the fibre content, as the fibre content was lower in both fermented and unfermented rice as compared to sweet potatoes in Table I. Although the crude fibre increased in sweet potatoes, it is higher than that reported by Jimoh and Olatidoye (2009) in yam (1.65%) and cassava (1.00%) as reported by Ikekoronye and Ngoddy (1985). Sweet potatoes could be composited with other dietary fibrous food to increase the fibre content to a recommended level. Fibre is reported to have beneficial effects on preventive cancer (Sharkar and Lanza, 1991). And dietary fibre helps reduce the chances of gastrointestinal problem and also reduce diabetic problems. The good ash content recorded shows that both samples could be a good source of minerals when fermented. As fermentation increases the ash content for fermented rice (5.00%) and sweet potatoes (5.00%) also increases. The decrease in carbohydrate content with fermentation for fermented rice (87.88% - 83.31%) was lower when compared to fermented sweet potatoes (85.92% - 38.50%). The lower content suggest that the yeast was able to breakdown the fermentable carbohydrates which were more in sweet potatoes than in rice. However, the high carbohydrate content observed in the unfermented food samples and the fermented rice indicates that they could be a good source of energy. Furthermore, the lower carbohydrate content in the fermented potatoes is also an advantage as reported by Ogunjobi et al., (2005) that low carbohydrate content food is medically recommended for diabetic patients. It is generally believed that fermented products have longer storage, shelf-life and improved nutritional qualities because of the organic acids and other desirable compounds produced during fermentation. Fermentation therefore, still remains the best technology in achieving improved food quality and food safety as reported in this study. This study have also shown that fermented sweet potatoes has an immense desirable nutritional qualities and could be added to the list of diets, considering especially the proportion of protein intake in the diet of most people in this part of the world.

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