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Full Length Research Paper

Microbiological, proximate analysis and sensory evaluation of processed Irish potato fermented in brine solution

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The microflora, proximate analysis and sensory evaluation of Irish Potato (*Solanum tuberosum*) slices fermented in 2.0% brine solution under micro-aerophilic condition for five days at room temperature were studied. The Nutritive qualities of the brined- fermented samples were analyzed and organoleptic parameters were accessed through trained panelist. There was an increase in microbial load of the brined-fermented samples especially within the first three days of fermentation as a result of hydrolysis of carbohydrate and subsequent conversion to sugars and minerals by the fermenting microorganisms. The organisms isolated from the fermentation set up include *Bacillus, Flavobacterium, Micrococcus, Lactobacillus* and *Staphylococcus* species. Decrease in microbial counts at the latter stages of fermentation was attributed to the high total acidity of the medium with reduction in pH from 7.50 to 5.03, while the lactic acid bacteria increased continuously throughout the period of fermentation. The results of the proximate analysis showed that there was a reduction in the crude fiber content from 28.96 to 20.04 mg/g, reducing sugar from 127 to 72 mg/g and ash content from 8.01 to 4.08 mg/g. The fried fermented chips were more desirable and preferred to the unfermented control.

Key words: Irish potato; brine, fermentation, microbes, proximate analysis, sensory evaluation.

INTRODUCTION

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 (Salaman, 1985). 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 (Onwueme, 1978). Anon (1985) reported that potato starch is a large-grained starch containing 25% amylase and 73% amylopectin and high phosphate content. Apart from the usual eating of the tuber, white potato is used in the fermentation of Vodka, as adhesive and sizing in paper and textile industries. The most common types of potato are the red and white. Most red varieties store longer than white varieties but most white varieties have better cooking qualities than red varieties (Kay, 1973).

Fermentation is one of the oldest and most widespread methods of preserving food. Practically all nations have some traditional type of fermented products made by the action of lactobacilli alone or in combination with other microorganisms (FAO, 1998). Fermentation has been viewed as a dynamic process during which several catabolic and anabolic reactions proceed simultaneously depending on several conditions, including substrate, microflora and environmental factors. Fermentation serves several important functions including enhancement or creation of unique flavours, change in textural properties and digestibility of foods (FAO, 1998). Fermenting fruits and vegetables can bring many benefits to people in developing countries. Fermented foods play

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an important role in providing food security, enhancing livelihoods and improving the nutrition and social well being of millions of people around the world. Fermentation leads to improved food preservation, increasing the range of raw materials that can be used to produce edible food products and removing anti-nutritional factors to make food safe to eat (FAO, 1998). Food processing is probably the most important source of income and employment in Africa, Asia and Latin America. The Food and Agriculture Organisation of the United Nations has stated that value added through marketing and processing raw products can be much greater than the value of primary production (Anon, 1995).

Some microorganisms make chemicals that can colour, flavour or stabilise foods. A large proportion of the Nigerian diets are made from fermentation processes. These types of food are important because of their increased nutritional values as well as improved flavour and aroma characteristics (Aderiye and Ogunjobi, 1998). The aim of this study was to determine the microbiological and chemical changes which occur during the fermentation of potato chips in 2.0% brine. The organoleptic parameters of the processed fermented potato are also evaluated.

MATERIALS AND METHODS

Source and fermentation of potatoes

The potatoes used in this study were purchased from main markets within the Ibadan metropolis. The potatoes were washed, peeled and cut into slices with the following dimensions; length 3-5 cm, width 1-2 cm and thickness 2-4 mm. Fifty grams of the potato tissues were submerged in 2.0% (w/v) sterile brine solution and allowed to undergo fermentation under micro-aerophilic condition at room temperature for five days. On a daily basis, sampling of each of the six sets of fermented potatoes slices was carried out for the total counts determination of microbial, coliform and lactic acid bacteria. The pH, total titratable acidity and proximate components of the potato tissue were also determined.

Microbiological analysis

Five grams of the fermented potatoes were homogenized in 45 ml sterile peptone-physiological salt solution and serially diluted to a concentration of 10^{-5} while all culturing were by the pour-plate methods. Total aerobic mesophilic counts were made on plate count agar after incubation at 30°C for 48 h; lactic acid bacteria counts were made on De man Rogosa and Sharpe (MRS) agar after 72 h of incubation at 30°C, while the enterobacteria counts after 24 h at 37°C were done on MacConkey and violet red bile glucose agar (Oxoid, CM485). The cultural methods of Aderiye and Ogunjobi (1998) were employed in microbial characterization. The microbial identification was according to the taxonomic tools of Sneath et al. (1986). All experiments were carried out in triplicates.

Chemical analyses

The AOAC (1990) methods were used in the determination of the hydrogen ion concentration and ash contents of the samples. The soluble protein, fat and fiber contents of the potato tissues were according to the methods of Lowry et al. (1951), Pearson 1975 and Kramer et al. (1949), respectively.

Cooking procedures

The fermented and fresh potato slices were processed into 4 edible forms: boiled, fried with palm oil, fried either with vegetable oil and roasted potato chips. These are methods used in Nigerian communities. Except for the roasted potatoes slices, which involved exposure of the fermented food to an oven temperature of 100°C until the colour changed to light brownish colouration usually lasting for 30–35 min, the other cooking procedures were carried out as described by Onwneme (1978).

Sensory evaluation

A trained panel of 15 persons evaluated the sensory attributes of the cooked fermented potatoes. Appearance, flavour, taste, texture and general acceptability were assessed. The scores were based on a seven point hedonic scale, where 7 represent excellent and 1 for very poor.

Statistical analysis

The ranking method of analysis was employed for the bacterial counts obtained from an average of the representative samples of both potato tissue and the supernatant (2.0% brine). The student's t-test was used in determining the significance of difference between the cooked potatoes samples.

RESULTS

The organisms implicated in the fermentation of the potatoes tissues were identified as species of *Flavobacterium Micrococcus, Pseudomonas*, *Staphylococcus* and *Bacillus* while *Lactobacillus plantarum*, *Lactobacillus brevis* and *Bacillus circulars* were obtained from the supernatants at different days of the fermentation. The pH of the fermenting medium decreased from 7.50 to 5.03 within 5 days of fermentation (Table 1). Also, the chemical composition of the potato tissues revealed that the moisture contents of the tissue increased gradually as the fermentation period increased.

There was a slight increase in the fat content of the brined samples from 0.025 - 0.040 mg/g while the protein content increased from 5.25 - 7.44 mg/g as the fermentation progressed until the fifth day. However, there was a reduction in the crude fiber (28.96 - 20.04 mg/g), reducing sugar (127 – 72 mg/g), ash (16.02 - 6.08 mg/g) and carbohydrate (21.47 - 14.34 mg/g) contents of the potato tissue (Table 1).

There was an initial increase in the total viable microbial and coliform counts to 13.2×10^8 and 2.8×10^6 cfu/ml of the fermenting medium, respectively, within the first three days of fermentation. The decrease in microbial counts after 72 h of fermentation may be attributed to pH change which is possibly not conducive to the coliform

Table 1. Proximate analysis, pH and Total titratable acidity of fresh and fermented Irish Potato.

Parameters	Potatoes Tissue					
	Fresh	1	2	3	4	5
Moisture (%)	65.31	68.17	69.77	71.03	72.33	74.13
Fat (mg/g)	0.025	0.035	0.035	0.036	0.029	0.040
Protein (mg/g)	5.25	5.69	6.12	6.25	6.94	7.44
Reducing sugar (mg/g)	127	116	105	94	84	72
Ash (mg/g)	16.02	9.86	8.84	762	6.28	8.08
Crude fiber (mg/g)	28.96	24.64	22.54	23.44	24.38	20.04
Carbohydrate (mg/g)	21.41	21.18	19.66	18.19	16.58	14.34
TTA %	0.02	0.05.	0.08	0.10	0.10	0.12
PH	7.50	6.67	5.55	5.35	5.10	5.03

The pH of 2.0% brine used was 8.09.

Table 2. The total viable microbial, lactic acid bacteria and coliform count (cfu/ml)* of potato tissue and fermentation medium.

Fermentation days	Total viable counts	Lactic acid bacterial counts	Coliform counts
1	5.6×10^8	2.1×10^6	2.6×10^6
2	11.5×10^8	2.7×10^6	2.8×10^6
3	13.2×10^8	3.8×10^6	2.8×10^6
4	7.4×10^8	4.4×10^6	1.2×10^6
5	6.9×10^8	5.0×10^6	1.0×10^6

*cfu/ml: colony forming unit per milliliter

Table 3. Sensory evaluation of processed fermented and unfermented potato tissues.

Procedure	Tissues	Texture	Appearance[a]	Flavour[b]	Taste	Chewiness[c]	General acceptability
Boiled	Fermented fresh	3.80±1.40	3.80±1.48	2.80±1.23	2.40±0.70	3.30±1.16	3.20±1.03
		4.50±1.18	4.90±0.88	3.70±1.16	3.90±1.45	5.10±0.57	4.40±1.03
Roasted	Fermented Fresh	3.00±1.05	3.20±1.25	3.60±0.84	3.90±1.20	3.50±0.35	3.50±1.35
		3.90±0.88	4.20±1.03	3.60±0.81	3.10±0.74	3.30±0.67	3.60±0.70
Fried with palm oil	Fermented Fresh	4.20±1.14	3.80±1.14	3.80±1.48	4.60±1.35	4.60±0.52	4.70±0.67
		4.10±1.20	3.10±0.92	3.10±0.99	2.8±0.92	4.40±1.17	3.40±0.97
Fried with vegetable oil	Fermented fresh	4.40±0.96	4.40±1.07	4.3±0.82	5.30±1.25	5.20±1.23	5.30±1.16
		4.4±0.97	4.4±0.07	3.90±1.10	4.00±1.49	5.10±0.99	4.50±1.18

a - include appeal; b- includes aroma; c - include ease of fragmentation.
Scoring system: 1 = Very poor; 2 = Poor; 3 = Fair; 4 = Average; 5 = Good; 6 = Very good; 7 = ExcellenT.

bacteria. Meanwhile, there was a steady increase in the lactic acid bacteria count from 2.1×10^6 to 5.0×10^6 with five days of fermentation (Table 2).

The result of the sensory evaluation revealed that the boiled fermented potato was the least accepted of all the four methods employed in processing the potato for consumption (Table 3) when general acceptability is considered. The fresh potato that served as control was more preferred (4.40) to the fermented (3.20) when both were boiled. On the whole, fermented potato slices fried with vegetable oil were more desired by the panelist than other method used in the processing with score of (5.30). It was better in appearance, flavour, taste and chewiness when compared to the roasted and fried with palm oil samples.

DISCUSSION

As part of the effect of changing the usual taste of eating the existing food items, brine fermentation of Irish potatoes was studied. The organisms isolated in the fermentation medium were bacteria that have been implicated in fermentation of different carbohydrate foods

in Nigeria (Odunfa, 1985; Aderiye and Ogunjobi, 1998). The role of the microorganisms in the process of fermentation showed that potatoes contain a fermentable material which was evident from the increase in the acidity of the fermenting tissues. The reduction in the coliform counts after 72 h of fermentation agreed with the study of Svanberg et al. (1992) where they demonstrated that the use of *Lactobacillus* strains in food to control the growth of enterotoxigenic *Ecsherichia coli*. Lactic acid bacteria are a group of Gram-positive bacteria that are of economic importance because they are applied extensively in both the production and preservation of a wide variety of food products (Bron et al., 2004). Thus, the increase in lactic acid bacterial counts in this study throughout the period of fermentation could be responsible for the reduction in the coliform counts.

It is generally believed that fermented products have longer storage and shelf life because the organic acids and other desirable compounds make the substrate unfavourable for proliferation of coliform and other undesirable microorganisms (Rose, 1982). Many consumers today are concerned about the synthetic chemicals used as preservatives in food and thereby making package processed food unpopular (Yang and Ray, 1994). It is therefore a better alternative to derive potato chips with natural preservation as the one prepared here which will meet consumer taste and acceptability. Interestingly, there was a corresponding increase in protein and fat content of the potato chips as a result of microbial fermentation. The increase in nutritive constituent of potato chips is an immensely desirable quality considering the proportion of protein intake as compared with carbohydrate in the diet of most people in this part of the world.

The reduction in carbohydrate from 21.41 to 14.34 mg/g and reducing sugar from 127 to 72 mg/g is also an advantage because low carbohydrate content food is medically recommended for diabetic patients. This disease is a major health problem in Africa. Diabetics are restricted to very few alternatives if you removed beans and unripe plantain from their diet. It would be appreciated if fermented potato chips in brine solution could be added to the list of diet for the diabetics to alleviate the threat of the disease as well as for relief.

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