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Fig. J. Nutr. Sci. 18 (1), 1997
Evaluation of Baked Products Based on Sorghum (Sorghum bicolor), Bambara Groundnut (Vigna subterranea L. Verdc) And Plantain (Musa paradisiaca) Flours

N. M. NNAM

Department of Home Science and Nutrition, University of Nigeria, Nsukka - Nigeria

ABSTRACT: The study evaluated the nutrient and sensory properties of baked products based on fermented sorghum (S), bambara groundnut (B)- and plantain (P) flours. The flours sources were fermented, dried and milled into fine flours. The flours were blended in ratios of 70:20:10, 65:30:5 (by weight) (S-B-P), 50:50:0 (by weight) (S-B-P). Standard recipes were developed and used to prepare baked products (muffins) from the composites and wheat flour. Product from wheat flour served as the control. The products were chemically and organoleptically evaluated using standard methods. The products from the composite flours contained higher levels of most of the nutrients tested. The products supplemented with plantain had higher mineral and sugar levels. The organoleptic attributes of the products were good. Acceptability of the composite flour products were comparable to that of wheat flour. The composite flours have promising baking and nutritional potentials and could serve as a nutritious substitute to wheat flour. Nig. J. Nutr. Sci. 10 (1): 30-33, 1997.

Key Words: Nutrients, organoleptic properties, composite flour, wheat flour, products.

INTRODUCTION

In Nigeria, a lot of traditional food crops with varied nutritional potentials are produced. The major problem confronting the nation is lack of adequate processing and preservation techniques which extend the food uses of the crops. Sorghum produced extensively in the northern part of Nigeria is the highest cultivated and harvested cereal crop in Nigeria [1]. Its food value is encouraging. The seeds contain about 10-15% protein, 68-80% starch, 3% and 2% ash. Like other cereal grains its protein limiting in lysine, threonine and tryptophan [2] make for amino acid balance, sorghum protein should be supplemented with legume protein. Bambara groundnut is an indigenous legume crop produced extensively in Northern Nigeria with limited uses [3]. Its protein is high 14-21 with more methionine than is found in other legumes [3]. It is a useful source of minerals and vitamins [4]. Plantain is another promising food crop desirable nutritional potentials. Nigeria is among large producers of the crop. In 1974, Nigeria was the second largest Africa producer and the third largest producer of the food crop [5]. Over 20% of the harvest is obtained during the peak period (September to February) and there is much wastage due to lack of adequate processing methods. Plantain is well accepted by all age groups. It is a useful source of carotene (pro-vitamin A), potassium and iron. Pulp contains 13-18mg ascorbic acid, 10-carotene and small quantities of phosphorus, calcium and sodium [6]. Plantain diets are easily digestible are good for children and adults with digestive problems. Sorghum, Bambara and Plantain have promising nutritional potentials at appropriately processed and blended could be used in baked food production. Wheat, the popular cereal baked product cannot be grown in humid tr areas, therefore supply must be imported to Nigeria. In the recent time, the Nigerian government t
NUTRIENT AND SENSORY EVALUATION OF BAKED PRODUCTS

The importation of wheat flour due to the high expenditure on foreign exchange. This limited its uses in the production of pastries and confectioneries in hotels and industries. The blends of some nutritious food crops particularly sorghum, bambara groundnut and plantain could serve as a replacement or substitute to wheat flour in baked products and extend the food uses of the crops. In composite flour formulation, the nutritional and organoleptic aspects of the products should be a major concern [7]. This is the thrust of the present work. Due to the favourable attributes of fermentation as a food processing method, the technology was used to process the foods. Fermented foods are known to have improved flavour, digestibility, nutrient density and decreased level of antinutrients. Fermentation results in overall improvement in nutritional quality of plant foods (8, 9, 10). The aim of the present work was to: (1) formulate composite flours from processed (fermented) sorghum, bambara groundnut and plantain (2) produce quick bread (muffins) from the composite flours and wheat flour and comparatively evaluate their nutrient composition and sensory properties.

MATERIALS AND METHODS

Preparation of materials:
Sorghum (Sorghum bicolor) (S), bambara groundnut (Vigna subteranea (L) Verdc) (BG) and plantain (Musa paraabsiaca) (PL) were used for the study. One kg of sorghum (white variety), five hundred grammes of bambara groundnut and two kg of plantain (green mature) were bought from Nsukka Wheat in Enugu State. The grains were cleaned. Bambara groundnut was dehulled and milled in a laboratory hammermill into a fine flour (70µm mesh). The flour was mixed with deionized water in a ratio of 1:3 (wt/vol) and allowed to ferment by the flora present in the paste for 48 hours at an average room temperature of 30 ± 2°C. Sorghum was milled into fine flour and fermented for 48 hours using the same technique as for bambara groundnut. The fermented samples were separately dried in an air oven at 55°C for 12 hours to 96% dry matter. Each of the fermented samples was remilled in a laboratory hammermill to fine powder (70µm mesh screen). The plantain fruits were hand peeled, sliced to thickness of about 15mm and soaked in water in a ratio of 1:3 (wt/vol) and allowed to ferment for 24 hours. The sample was dried and milled to fine powder as in sorghum and bambara groundnut.

Composite flour formulation:
The protein levels of the foods were analyzed using the micro-Kjeldahl procedure of AOAC [11]. The composites were formulated based on ratios of 70:30:0, 70:25:5 and 63:30:5 (protein basis) of sorghum, bambara groundnut and plantain.

Preparation of baked products (muffin)
One hundred grammes of each of the composite flour was sifted, mixed with baking powder (10g), salt (pinch) and sugar (20g). The mixture was combined with melted shortening (60g) and water (85ml) and poured into greased muffin pans to bake at 195°C in an oven until golden brown. 100% wheat flour was used to prepare the control using the same recipe.

Laboratory Analysis:
All the products (muffin) were separately dried in an air oven at 55°C for 12 hours to 96% dry matter. The samples were milled into fine flour (70mm mesh screen) in a laboratory hammermill. All the nutrients were determined in triplicate using the standard assay methods of AOAC [11] for proximate and mineral compositions. Residual moisture was determined by the hot air oven method [12]. This allowed all comparisons to be done on dry solid matter basis. Starch and total sugar were determined by the sulphuric-phenol method of Dubois et al [13].

Sensory evaluation:
A nine point hedonic scale [14] where 9 was the highest score and 1 the lowest was used to test for flavour, texture, colour and general acceptability of the products. The degree of likeness was expressed as like extremely (9 points), like very much (8 points), like moderately (7 points), like slightly (6 points), neither like nor dislike (5 points), dislike slightly (4 points), dislike moderately (3 points), dislike very much (2 points) and dislike extremely (1 point).
NNAM

extremely to like slightly constituted good while dislike slightly to dislike extremely constituted poor. Neither like nor dislike showed that the product is neither good nor poor. One hundred consumer panellists randomly selected from Nsukka town participated in the sensory evaluation. The judges were divided into two groups. Morning and afternoon evaluation sessions were organised for the groups. The testing was conducted in the food research laboratory of the Department of Home Science and Nutrition, University of Nigeria, Nsukka. The products were presented in small saucers to each of the panellists seated in a properly lighted compartment. The products were coded using three digits (RUM, AAA, JJJ, BBG) which corresponded with the codes included in the hedonic scale used for the evaluation.

Statistical analysis
All the data were subjected to one way analysis of variance. The means and standard error of the means were calculated using Steel and Torrie procedure [15]. Significance was accepted at $p \leq 0.05$.

RESULTS AND DISCUSSION

The nutrient composition of muffins developed from wheat flour and fermented sorghum, bambara groundnut and plantain composite flours is shown in Table 1. The protein levels of the products varied. The product from S:BG:PL (70:30:0) composite had the highest protein ($p \leq 0.05$). Supplementing either the cereal or the legume with plantain lowered protein level however, all the products from the composite flours contained more protein than the product from wheat flour ($p < 0.05$). This shows the desirable effect of food supplementation. When vegetable foods are judiciously combined, they give a composite with enhanced nutritional attributes [16].

The total carbohydrate (CHO) ranged from 64.78% in the S:BG:PL (70:30:0) to 74.76% in the wheat product. The products from wheat flour contained more CHO than those from the processed composite flours ($p < 0.05$) while the product not supplemented with plantain had the least level ($p < 0.05$). The lower CHO might enhance the level of other nutrients.

The products from the composites contained more lipid than the wheat flour product ($p < 0.05$). The higher lipid levels increased energy densities of the products. The ash values of the products varied with the different combinations. The products supplemented with plantain contained more ash than others ($p < 0.05$). This suggests high mineral levels.

The total sugar levels of the composite flour products were higher than that of wheat flour. Addition of 5% plantain to supplement either the cereal or the legume increased the sugar levels ($p < 0.05$). The fermented composite flours gave products with more sugar than the wheat flour. The higher sugar levels of the products from fermented composite flours might be due to microbial activity during fermentation. It is known that fermentation leads to increased activities of α-amylases which hydrolyse starch to much more soluble and digestible sugars [17, 18].

The product from wheat flour contained more starch than those from the processed composite flours ($p < 0.05$). The lower starch levels of the products from processed flours were due to fermentation which converted the starch molecules to simple sugars. Starch hydrolysis is known to reduce bulk and increase digestibility [7].

The iron (Fe) levels of the products were influenced by the food sources. Wheat flour product contained lower Fe than others ($p < 0.05$). The composites supplemented with plantain gave products with higher Fe levels than the unsupplemented. This shows the beneficial effect of combining more than two foods (multi-mixes). Zinc (Zn) nutriture followed the same trend as Fe. The composite flour products contained more Zn than the wheat flour ($p < 0.05$).

The calcium (Ca) levels of the products varied. The wheat flour product contained more Ca than the composites ($p < 0.05$). Supplementing the legum with 5% plantain gave more Ca than supplementing the cereal. The product that contained no plantain had the least calcium ($p < 0.05$).

The products contained significant amount of phosphorus (P) [410.21mg in wheat product to 481.67mg in S:BG:PL (70:25:5)]. The composite flour products contained more P than the wheat flour (p...
Generally, the composites gave products with higher mineral levels and better nutrient balance than wheat flour. The sensory properties of muffins developed from wheat flour and fermented sorghum, bambara groundnut and plantain composite flours are shown in Table 2. The flavour of the wheat flour muffin was liked very much while that of the composites were liked moderately. The panellists liked the texture and colour of the products moderately. The general acceptability of the products was influenced by the various organoleptic attributes of flavour, texture and colour. The wheat flour product was liked very much in terms of acceptability while others were liked moderately.

However, there was no significant \( p > 0.05 \) difference in the degree of acceptance among the products. All the products were good. The composite flour products have promising nutritional and organoleptic attributes. Relative to wheat flour, the composites gave products with higher protein, lipid, total sugar, Fe, Zn and P. The nutrient composition of the composite products is of benefit. The use of the composite flours for baked food production should be fully explored in Nigeria. The composite could serve as a nutritious substitute to wheat flour and provide more varied uses for the traditional food crops.

Table 1: The Nutrient Composition of Muffins Developed from Wheat Flour and fermented Sorghum, Bambara groundnut and Plantain Composite Flours (dry weight basis)

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<tr>
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<th>SPROFL</th>
<th>BGRFL</th>
<th>BPLFL</th>
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<tbody>
<tr>
<td>Protein (%)</td>
<td>16.60±0.02</td>
<td>15.24±0.01</td>
<td>15.13±0.01</td>
<td>9.62±0.01</td>
</tr>
<tr>
<td>Total Carbohydrate (%)</td>
<td>64.78±0.02</td>
<td>66.13±0.01</td>
<td>68.32±0.01</td>
<td>74.76±0.04</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>12.4±0.01</td>
<td>12.01±0.01</td>
<td>12.21±0.01</td>
<td>10.46±0.01</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>4.2±0.01</td>
<td>6.62±0.01</td>
<td>6.12±0.04</td>
<td>5.16±0.02</td>
</tr>
<tr>
<td>Total sugar (g)</td>
<td>22.4±0.04</td>
<td>24.27±0.01</td>
<td>24.09±0.01</td>
<td>21.21±0.04</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>42.37±0.01</td>
<td>41.86±0.01</td>
<td>43.84±0.01</td>
<td>47.53±0.02</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>3.6±0.01</td>
<td>6.24±0.02</td>
<td>6.02±0.01</td>
<td>3.45±0.01</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>6.0±0.01</td>
<td>5.12±0.06</td>
<td>5.67±0.01</td>
<td>3.02±0.01</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>94.0±0.04</td>
<td>120.42±0.04</td>
<td>106.21±0.03</td>
<td>127.04±0.06</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>43.2±0.02</td>
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Note: SSCP § 3 determinations. Mean not followed by the same letter along the same horizontal line are significantly \( p < 0.05 \) from each other.

Table 2: The Sensory Properties of Muffins Developed from Wheat Flour and Fermented Sorghum, Bambara groundnut and Plantain Composite Flours

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<td>Flavor</td>
<td>7.02±0.72</td>
<td>7.28±0.49</td>
<td>7.16±0.61</td>
<td>8.21±0.67</td>
</tr>
<tr>
<td>Texture</td>
<td>7.27±0.46</td>
<td>7.16±0.31</td>
<td>7.21±0.86</td>
<td>7.89±0.73</td>
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<td>Colour</td>
<td>7.23±0.68</td>
<td>7.14±0.92</td>
<td>7.01±0.55</td>
<td>7.57±0.92</td>
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<td>General Acceptability</td>
<td>7.31±0.57</td>
<td>7.11±0.90</td>
<td>7.38±0.97</td>
<td>8.07±0.41</td>
</tr>
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Scores are based on 9-point hedonic scale: where score 9 = Like extremely
8 = Like very much
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2 = Dislike very much
1 = Dislike extremely

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