Research Journal of Biological Sciences 1 (1-4): 20-23, 2006

Microbial and Nutritional Evaluation of Infant Weaning Food from Mixture of Fermented Food Substrates

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Abstract: Soybeans, ripe and unripe banana were dried, milled and formulated in graded mixtures with maize or sorghum as the food base. The blends were separately fermented at 30±2°C for 72 h. The microbial load and types, pH and proximate analyses of the fermenting mixtures were investigated. The following bacteria and fungi were isolated during fermentation; *Bacillus cereus, Clostridium bifermentans, Corynebacterium sp, Leuconostoc mesenteroides, Micrococcus liteus, Staphylococcus aureus and Aspergillus flavus, Aspergillus niger, Mucor mucedo, Rhizopus stolonifer and Saccharomyces* sp. The bacterial counts ranged between 3.0×10^6 to 10×10^6 cfu mL^{-1} for blends with maize base and 2.0×10^6 to 24×10^6 cfu mL^{-1} for blends with sorghum base for the period of fermentation. Three blend viz; Maize + Unripe banana + Soybean (MUS), Sorghum + Unripe banana + Soybean (SUS) and Sorghum + Ripe Banana (SRB) were found to be adequate in protein (18.20, 21.11 and 19.63%), fat (14.60, 7.76 and 13.21%) and ash (3.87, 2.33 and 1.4%), respectively. These compositions compared favourably with some previously reported studies on weaning foods in Nigeria, such as "soy-ogi" and also with the Protein Advisory Group of United Nations weaning recommendations. MUS, SUS, SRB may therefore be used as potential weaning foods.

Key words: Weaning food, soybean, banana, nutritional content

INTRODUCTION

Weaning is a gradual stoppage of feeding a baby with the mother's milk and start feeding it with solid food. The transition from milk to solid or adult food is a critical period in the life of a child as the weaning practices by the mother profoundly determines the child's growth and development (Hart *et al.*,[1]). This period which could start from four months of age, varies from one social economic status to the other. The large number of study of nutritional disorders like marasmus and kwashiorkor due to protein energy malnutrition observed during weaning period can be reduced through the use of nutritionally balanced home produced weaning foods (Omololu,[2]).

In most developing countries and particularly in Nigeria, traditional weaning foods are based on local starchy staples usually fermented, ground cereals that are processed into porridges such as Ogi. Maize and sorghum have been widely used to produce Ogi which is a popular weaning food in Nigeria. Although maize has been reported not to be a good source of high quality protein since it is deficient in tryptophan and lysine which are essential amino acids (Akinrele and Edwards,[3]). Protein of fermented maize or sorghum flour is much poorer than that of the whole grain because of processing losses, this result in the children that are fed with 'ogi' not receiving enough essential amino acid to meet their body needs and resistance to disease. In order to enhance the nutritional value, this investigation has made use of soybean and banana (ripe and unripe), been widely grown and consume all over Nigeria to boost the nutritional qualities of Ogi produced from either maize or sorghum in various combinations.

MATERIALS AND METHODS

Materials used are; white maize, brown hull sorghum, soybean and banana (ripe and unripe), were purchased from a local market in Akure, Ondo State. The maize and sorghum were dry milled and packed separately in to cellophane bag. Soybean was ground, willowed and dry milled. The banana (ripe and unripe) was also prepared into powdery form. The flour was obtained by peeling, pulping and slicing into thin slices. The slices were then dried in the air-oven at 60°C. The dry slices were then milled into flour.

Formulations: The maize flour and sorghum flour were compounded into whole diets with the inclusion of one or

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two substrates as show in Table 3. The blends were thoroughly mixed and soaked in 500ml of water and the content allowed to ferment for 3 days at temperature 30±2°C. The fermented blends were grounded to a smooth slurry in a Moulinex blender after decanting the steep water. The slurry was washed through a fine sieve with excess water, the coarse particles discarded and the slurry allowed to settle for 2 h. The washing water was decanted and the sediment was transferred to a clean muslin cloth and squeezed to remove excess water. The sediment was place on an alumminium foil and dried at 50°C till bone dry in an air oven. The fried foods were then pulverized into fine texture flour by blender and then kept separately in a polythene bag until use (Banigo and Akpapunam,[4]).

Microbial evaluation: The microbial load of each fermenting mixture was carried out on a daily basis from 0 hour to 72 h. Pure colonies of isolated organisms were obtained and biochemical investigations were carried out for identification of each.

Chemical analysis: The pH of the fermenting samples were taken daily from 0 to 72 h of fermentation using Jenway pH metre standardized with appropriate buffers. The moisture, protein (N × 6.25), fat, ash and crude contents of the dried fermented samples were determined by A.O.A.C. methods, while the carbohydrates content was calculated by difference.

RESULTS AND DISCUSSION

The recipes obtained from the mixtures of the fermented food substrates investigated contained both bacteria and fungi. The bacterial count ranged from 3.0×10^6 to 19×10^6 cfu mL^{-1} for blends with maize base and 2.0×10^6 to 24×10^6 cfu mL^{-1} for blends with sorghum base (Table 1). Similar report by Roubouts and Nouts[5] revealed that bacterial counts obtained in plants food were in the order of 12×10^7 to 10^8cfug. Meanwhile the range of counts obtained is on the high side when compared to the International Microbiological standard recommended limit of bacteria contaminants for food, of less than 10^6 cfu/g (Anon,[6]). The high values of the microbial load may not be unexpected because of the environments and the treatment they might have been exposed to during storage.

The various type of bacteria and fungi isolated are *Bacillus cereus, Clostridium bifermentans, Corynebacterium* sp., *Lactobacillus plantarum, Lactobacillus fermentum, Leuconostoc mensenteroides, Micrococcus luteus, Staphlococcus aureus and Aspergillus flavus, Aspergillus niger, Mucor mucedo, Rhizopus stolonifer and Saccharomyces* sp.

Table 1: Total viable bacterial count during the period of fermentation of the food samples (10^6 cfu mL^{-1})

Sample	Period of Fermentation (Hrs)			
	0	24	48	72
MOY	4.0	8.0	10.0	6.0
SOY	2.0	6.0	16.0	6.0
MSB	7.0	10.0	18.0	6.0
SSB	6.0	10.0	24.0	5.0
MUB	3.0	9.0	14.0	3.0
SUB	4.0	7.0	16.0	4.0
MRB	4.0	8.0	9.0	2.0
SRB	3.0	9.0	11.0	5.0
MUS	5.0	11.0	17.0	6.0
SUS	5.0	12.0	17.0	8.0
MRS	6.0	11.0	14.0	7.0
SRS	5.0	10.0	12.0	4.0

Table 2: Changes in pH of the food samples during fermentation

Sample	Period of Fermentation (Hrs)			
	0	24	48	72
MOY	5.70	4.00	3.75	3.70
SOY	5.93	3.97	3.44	3.41
MSB	5.42	4.30	4.00	3.90
SSB	6.02	4.68	3.70	3.63
MUB	5.20	4.20	3.80	3.15
SUB	5.49	4.01	3.80	3.78
MRB	4.50	4.45	3.60	3.55
SRB	4.61	4.31	3.78	3.39
MRS	5.40	4.70	3.95	3.95
SRS	5.47	4.44	3.67	3.58
MUS	5.50	4.30	3.90	3.90
SUS	6.04	4.17	3.96	3.87

Halm *et al.*,[7] reported that *Corynebacterium* sp, *Lactobacillus plantarum, Leuconostoc, Cephalosporium, Fusarium, Aspergillus* and *Penicillum* sp are responsible for the fermentation of corn during steeping. Another report by Roubouts and Nouts[5] revealed that fungi, especially *Rhizopus* sp and *Mucor* sp play an essential role in tempe fermentation.

The implication of this isolates are both beneficial and harmful. *Lactobacilli* have been implicated for the fermentation of grains. The process is beneficially used to improve the nutritional quality of cereals and reduce bulk in infant feeding. It can also improve the digestibility of protein and energy (Egbekun,[8]). The fungi present in the fermentation vessel utilize the residual sugars and converts some of them to ethanol and carbon dioxide with subsequent effects upon the food. Presence of some of the isolates may pose a threat to man. *B. cereus* and *S. aureus* and food poisoning agents and strains of *Aspergillus* are known to be toxin-producers (Broadbent,[9])

The pH of the food samples decreased as the period of fermentation progressed (Table 2). This was due to the action of lactic acid fermenter present in the food samples.

Table 3: Composition of the food blends (%)*

Blends	Moisture	Crude-Protein	Fat	Carboh-Ydrate	Ash	Crude Fibre
Fermented Maize flour (MOY)	7.15	10.80	4.80	72.68	2.90	1.67
Fermented sorghum flour (SOY)	7.65	12.64	12.18	64.86	1.25	1.42
Sorghum + soybean (SSB) (50:50)	5.37	29.73	22.78	33.61	1.73	6.78
Maize + unripe banana (MUB) (50:50)	12.68	17.79	8.25	49.34	7.36	4.58
Sorghum + unripe banana (SUB) (50:50)	5.76	12.94	12.60	65.68	1.84	1.18
Maize + ripe banana (MRB) (50:50)	10.82	19.78	15.00	46.89	4.35	3.16
Sorghum + ripe banana (SRB) (50:50)	6.17	19.63	13.21	57.93	1.47	1.59
Maize + unripe banana + Soybean (MUS) (34:33:33)	11.68	18.20	14.60	49.55	3.87	2.10
Sorghum + unripe banana + Soybean (SUS) (34:33:33)	6.05	21.11	7.76	60.26	2.33	2.49
Maize + ripe banana + Soybean (MRS) (34:33:33)	11.45	35.75	19.20	21.52	7.19	4.89
Sorghum + ripe banana + Soybean (SRS) (34:33:33)	7.60	28.0	7.05	47.39	2.20	7.76
FAO/WHO/UNICEF/PAG	5.10	≥20.0	≥10.0	≤5.0	≤5.0	1.0

* mean value of two replicates, on dry weight basis

The microbial load which increased at the early h declined at the later h. This is due to the lowering of pH values, resulting in the medium being more acidic and unfavourable for the proliferation and growth of the microorganisms.

Table 3 shows the result of the proximate composition of the blends. The protein content ranges between10.80% to 40.08%. It was observed that blends containing soybean has high percentage of protein. This is supporting the report of Akinrele and Edward[3] that soybean is high in protein compared to other seeds. The crude fibre content of infant food is expected to be low (less that 1) as food with high fibre contents tends to cause indigestion in babies. Hence, samples with low fibre content were rated good as potential weaning foods. Ketiku and Smith[10] reported that there was less than 1% fibre in Apapa Multimix while Makinde *et al.*,[11] confirmed that soy-ogi contained negligible percentage of fibre contents. Samples that had their fibre content less than 3% are maize only (1.67%), sorghum only (1.42%), sorghum + unripe banana (SUB) (1.18%), sorghum + ripe banana (SRB) (1.59%), sorghum + unripe banana + soybean (SUS) (2.49%) and maize + unripe banana + soybean (MUS) (2.10%).

Blends containing banana (ripe and unripe) had high moisture contents. This could be as a result of high moisture content of banana, this makes it susceptible to moulding and caking. Ketiku and Smith[10], Makinde *et al.*,[11] and PAG of United nations[12] recommended 17.7, 16.5 and 20% protein content inclusion. MUS, SUS and SRB blends were found to be adequate in protein with 16.20, 21.11 and 19.63%, respectively.

MUS, SUS and SRB contained 14.60, 7.76 and 13.21% of fat, respectively. FAO/WHO/PAG/UNICEF recommends less than 10% fat. The ash content for MUS, SUS and SRB were 3.87, 2.33 and 1.47%, respectively, which are compared favourably with PAG 5% recommendation. And for the moisture content, standard percentage recommended is 5-10% while MUS contained 11.68, SUS 6.05 and SRB 6.17%.

Since banana contain no significant level of toxic property and the trypsin inhibitor in soybean had been removed by winnowing, soaking and heating process during preparations.

The food substrates (Soybean and banana) used has complementary effects on the nutritive value on the weaning foods. Soybean supplies the required proteins while banana enhances the taste and digestibility. The food items used are relatively available and affordable to the low-economic mothers while still meeting up with the nutritional requirements weaning babies at no extra cost.

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