PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 7 (1): 21-26, 2008
ISSN 1680-5194

Physicochemical and Microbial Qualities of *Dambu* Produced from Different Cereal Grains

H.O. Agu[1], A.N. Anosike[1] and I.A. Jideani[2]
[1]Department of Food Science and Technology, Federal Polytechnic Bauchi, P.M.B. 0231, Bauchi, Nigeria
[2]National Food Technology and Research Centre, Private Bag 008, Kanye, Botswana

Abstract: *Dambu*, a steamed granulated dumpling product generally made from millet, was produced from maize, millet, sorghum and acha (*Digitaria exilis*). The decorticated clean cereal grains were pulverized into coarse particles mixed with spices and water and steamed. Physicochemical analysis, sensory quality and the microbial quality of the *Dambu* were all carried out. Percentage proximate composition of the products ranged in values with moisture content 29-33, ash 2.0-3.0, protein 7.3-11.7, fat 5.4-8.8 and carbohydrate 46.8-53.3. During storage, pH decrease (7.6 to 5.1) was observed, while titratable acidity increased (1.8 to 8.1) for all the products. The bacteria load (cfu/g) of the four *Dambu* products increased with time under the following storage conditions: refrigeration (3.1×10^5 to 1.7×10^6), cupboard (1.4×310^6 to 8.5×10^6) and laboratory shelf (1.2×10^6 to 1.2×10^8). The fungal count (cfu/g) also increased with time under the storage conditions: refrigeration (2.3×10^5 to 1.2×10^6), cupboard (1.5×10^6 to 6.5×10^6) and laboratory shelf (2.1×10^6 to 9.5×10^6). In terms of sensory quality there was no significance difference ($p>0.05$) in the mean scores for all the assessed parameter except the texture of the products.

Key words: *Dambu*, spices, maize, millet, sorghum, acha, bacteria, fungi

Introduction

Cereals are the fruits of cultivated grasses and members of the grass family Graminae (Poaceae). The cereals crops like wheat, maize (*Zea mays*), millet (*Pennisetum typhoides*), sorghum (*Sorghum bicolor*) and acha (*Digitaria exilis*) (Jideani, 1999) are the major plant foods. Cereals have been important crop for thousands of years, indeed the successful production, storage and use of cereals have contributed in no small measure to the development of modern civilization (Kent, 1983). Cereal grains are plant seeds and as such contain a large centrally located starch endosperm which also is rich in protein, a protective outer coat consisting of two or three layers of fibrous tissue and an embryo or germ usually located near the bottom of the seed. Except for two amino acids, lysine and tryptophan, most cereals contain the essential amino acids required by man as well as vitamin and mineral. When they are consumed with other foods, they can supplement the nutritional elements that are low in cereal (Ihekoronye and Ngoddy, 1985).

Dambu is a steamed granulated dumpling generally made from millet, maize and sorghum. It can also be defined as non-fermented formulated dumpling in Nigeria. It is known as *Dambu* among the Hausas and as nyamri among the Fulanis. *Dambu* is produced mainly from moistened millet flour blended with spices and steamed for thirty minutes. Sorghum, maize and acha may replace millet depending on the locality and availability of the grain. *Dambu* has coarse particles resembling moistened couscous. It is sprinkled into fermented skimmed milk (nono), or fermented wholemilk (kindrimo) and sugar may be added to taste. It is a popular mid day meal (Nkama *et al*., 1999).

Dambu is produced at home both for family and commercial consumption. Most *Dambu* producers use the traditional method involving wooden mortar and pestle to dehull and mill the cereal grains. The traditional pounding process is a tedious task, which limits the use of cereal grains in most countries of Africa (Jideani *et al*., 2001). Moreover, because the cereal flour spoils quickly and cannot be kept for later use, it has to be milled perhaps on daily basis each time *Dambu* is needed. Furthermore, *Dambu* like fura (Jideani *et al*., 2001) has a limited shelf life of 2 days at tropical ambient temperature (25±3°C) and also due to lack of packaging for this product.

The production of *Dambu* with different types of cereal grains is possible especially where a particular cereal is lacking, the other grains could be used as a substitute. Different cereal grains are also used for health reason, especially diabetic patients. Acha could be used as a substitute since it is consumed as intact grain and may make for small increase in blood glucose level (Gopalan, 1981). This research is aimed at (i) production and sensory evaluation of *Dambu* made from maize, sorghum, millet and acha and (ii) physicochemical and microbial load of *Dambu* produced from the different cereal grains.

Materials and Methods

Source of materials: The materials used include millet (*Pennisetum typhoides*), acha (*Digitaria exilis*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), spices such

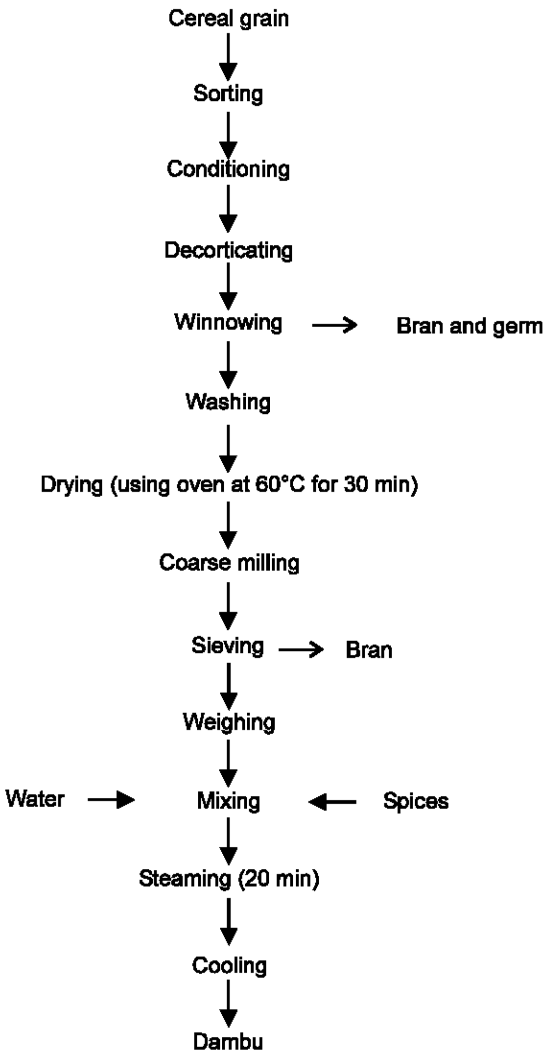

Fig. 1: Flow chart of modified traditional method of *Dambu* production from millet, maize and sorghum grains

as cloves (*Zyghum aromaticum*), ginger (*Zingiber officinale*) and black pepper (*Pepper nigrum*). The spices were milled separately into powder. These materials were purchased from Wand Market in Bauchi, Nigeria. The chemicals were of analytical grade and purchased from Sigma or BDH company, UK.

Production of *Dambu* from millet, maize, sorghum and acha: Each of the grains was sorted differently to remove stalks and other foreign materials. For millet, maize and sorghum, water was sprinkled on the grains to raise the moisture content for easy removal of the seed coat. The grains were then decorticated differently using Amuda Rice Huller with polisher (India) and winnowed manually to separate the endosperm from the bran. The grains after washing to remove all dirt were dried separately in

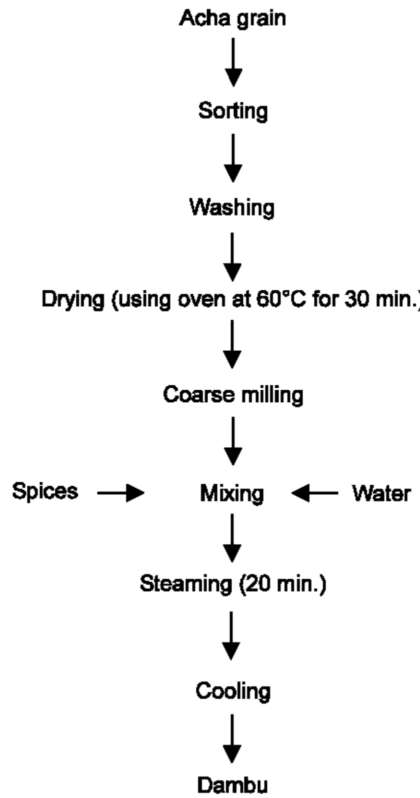

Fig. 2: Flow chart of dambu produced from acha (Digitaria exilis) grain

an oven (PROLABO ètuve isotheme, 54635, France) at a temperature of 60°C for 30 min. The drying process reduced the moisture content and the grains were grounded separately into coarse texture using Hammer mill. The coarse texture products were sieved differently to remove further unwanted bran present in the flour using 600 µm sieve (England). To each type of flour (150 g) was added 0.7 g of black pepper, 1.5 g of ginger, 0.5 g of cloves and 60 mL of water. The mixtures were mixed separately using spoon and steamed using a two-fold system, having a perforated plate containing the product and placed on a pot containing boiling water. The preparation was cooked for 20 min, allowed to cool and dished into plastic plates for sensory evaluation. Fig. 1 shows the production of *Dambu* from maize (DMA), *Dambu* from millet (DMI) and *Dambu* from sorghum (DSO).

For acha, the cleaned grains were washed to remove dust and dried in the oven at 60°C for 30 min. to reduce the moisture content. The grains were grounded as in the other cereal grains and the wholemeal flour sieved to remove unwanted particles. Acha flour (150 g) was processed as described for the other flours. The flow chart showing the production of *Dambu* from acha (DAC) is shown in Fig. 2.

Table 1: Formulation of ingredients for *Dambu* production[a]

Ingredients (g)	DMA	DML	DSO	DAC
Flour	150	150	150	150
Ginger	1.5	1.5	1.5	1.5
Black pepper	0.7	0.7	0.7	0.7
Cloves	0.5	0.5	0.5	0.5
Water (mL)	60	60	60	60

[a]DMA = *Dambu* made from maize, DMI = *Dambu* made from millet, DSO = *Dambu* made from sorghum and DAC = *Dambu* made from acha

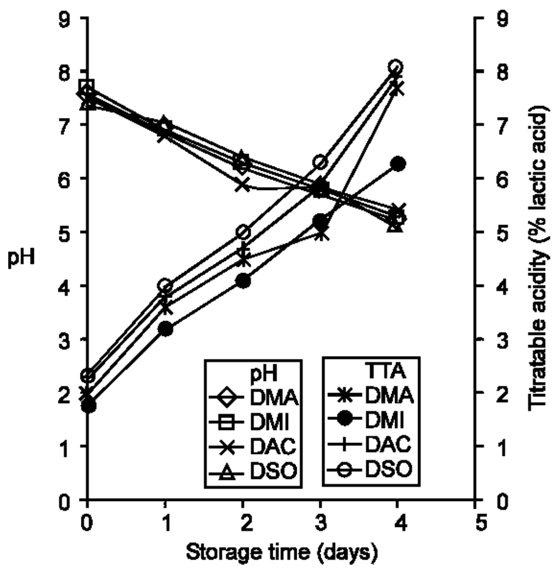

Fig. 3: Effect of storage time on the pH and titratable acidity of dambu produced from different cereal grains. Dambu made from maize (DMA), millet (DMI), sorghum (DSO) and acha (DAC)

Sensory evaluation of *Dambu* products: The four *Dambu* products (DMA, DMI, DSO and DAC) were subjected to sensory evaluation. A total of 20 untrained panelist drawn from the Federal Polytechnic Bauchi based on their familiarity with the product were used for the evaluation. The parameters tested included texture, colour, odour, taste and overall acceptability (Ihekoronye and Ngoddy, 1985). The nine-point Hedonic scale was used for the evaluation and the resulting data was analyzed using ANOVA. Tukey's test was used to determine any significant difference between the samples in terms of parameters chosen at 5% confidence level.

Proximate analysis of *Dambu*: Proximate analysis was carried out as described by Egan *et al.* (1981). Moisture content was determined using hot air oven method. Fat determination was done using soxhlet method. Protein determination was done using the macro Kjeldahl method. Ash content was done using the muffle furnace (0H-85TR, Hungary). The carbohydrate content was determined by difference (Egan *et al.*, 1981). The pH was determined using pH meter (ELE International, UK). The pH of *Dambu* samples stored at ambient temperature for 4 days were also determined. The total titratable acidity, as lactic acid, of the products stored at 25±3°C was carried out by titration (Egan *et al.*, 1981).

Microbial analysis of *Dambu*: Inoculum preparation involved weighing out 1.0 g of each *Dambu* sample stored at different storage conditions into 9 mL of 1% peptone water and homogenized by shaking for 3 min. Subsequent serial dilutions of up to 10^{-4} of each sample were made. The bacteria count was done daily using 0.1 mL of 10^{-4} dilution of the freshly prepared *Dambu* sample and samples stored in the refrigerator, cupboard and laboratory shelf. The 10^{-4} dilution was inoculated in triplicate unto nutrient agar and incubated at 37°C for 24 h (Buchanans and Gibbons, 1974). The number of colonies that developed on the plates were counted using electronic colony counter (Gallenkamp, 443 300 66087, UK) and the result expressed as colony forming unit per gram (cfu/g) of the sample by multiplying the number of colonies on each plate by the specific dilution factor (Buchanans and Gibbons, 1974). The procedure is based on the assumption that each viable cell will develop into a colony, hence the number of colonies on the plate reveals the approximate number of organisms contained in the sample (Collins and Lyne, 1987).

The fungal count of *Dambu* samples was enumerated using the plate count technique (Collins and Lyne, 1987). In this technique 0.1 mL of 10^{-4} dilution of each sample was inoculated in triplicate using potato dextrose agar. Incubation was at room temperature (25±3°C) for 72 h (Collins and Lyne, 1987). After incubation the number of colonies that developed on the plates were counted using electronic colony counter. The result was expressed as cfu/g of the sample by multiplying the number of colonies of each plate by the specific dilution factor.

Results and Discussion

Physicochemical characteristics of *Dambu* from different cereal grains: The moisture content of *Dambu* produced from maize (DMA), millet (DMI), sorghum (DSO) and acha (DAC) are as shown on Table 2 and ranged between 29.0 to 32.5%. The moisture content of DMA was significantly different (p<0.05) from that of DMI, DSO and DAC. Pearl millet kernels are about 8.9 g per 1000 seed weight, about one-third the weight of sorghum (Hulse *et al.*, 1980). The starch granules of millet and acha appear to absorb more moisture than maize and sorghum granules. This explains the high moisture content of *Dambu* made from millet and acha. This result is in agreement with those of Akingbala *et al.* (1994), Cheftel *et al.* (1989) and Ayo (2001). Extremely

Table 2: Physicochemical characteristics of *Dambu* produced from maize (DMA), millet (DMI), sorghum (DSO) and acha (DAC)[a]

	Component (%)[b]						
Samples	Moisture	Total ash	Crude protein	Fat	Carbohydrate	Texture	Colour
DMA	29.0±0.0[a]	3.4±0.4[c]	10.5±0.3[b]	8.8±0.1[d]	48.3±0.2[a]	Coarse	Creamy
DMI	32.5±0.7[b]	2.4±0.1[b]	7.3±0.4[a]	8.2±0.1[c]	49.1±0.1[a]	Coarse	Dark green
DSO	31.7±0.2[b]	2.4±0.1[b]	11.3±0.3[b]	7.8±0.1[b]	46.8±0.2[a]	Coarse	Golden brown
DAC	32.0±0.7[b]	2.0±0.3[a]	7.3±0.4[a]	5.4±0.2[a]	53.3±0.1[a]	Fine	Creamy

[a]Values with different alphabets in each column are significantly different (p<0.05), [b]Mean±Standard deviation of triplicate determinations

Table 3: Sensory qualities of *Dambu* products[a]

Product[b]	Odour	Texture	Colour	Taste	Overall Acceptability
DMA	7.60[a]	7.50[a]	7.10[a]	7.60[a]	7.50[a]
DMI	6.90[a]	7.50[a]	7.05[a]	6.90[a]	7.45[a]
DSO	7.10[a]	7.70[a]	7.55[a]	7.10[a]	7.40[a]
DAC	7.00[a]	6.45[b]	7.15[a]	7.00[a]	6.70[a]
LSD	0.85	1.02	0.99	0.92	0.85

[a,]Means with different superscript within the same column differ significantly (p<0.05), [b]DMA = *Dambu* from maize, DMI = *Dambu* from millet, DSO = *Dambu* from sorghum and DAC = *Dambu* from acha

small particles enhance absorption of water and also increased surface area improves moisture content. Generally the moisture contents of all the *Dambu* products were high enough to support the growth of micro-organism. High moisture content in food may increase microbial growth problem (Giese, 1993).

The ash contents of the four *Dambu* products fall within the ranged 2.0 to 3.4% (Table 2). The products from the respective cereals were significantly different (p<0.05) from one another, except for millet and sorghum that were not significantly different. Their differences could be attributed to the ash content of maize (3%), sorghum (2%), millet (2%) and acha (2.1%) grains. The slight increase in ash content of the products compared to the grains could be as a result of the added spices which facilitated the increase of the ash content. This suggests that the *Dambu* products contain mineral element more than the grains, therefore giving them nutritional advantage. The protein content of *Dambu* products fall within the range 7.3 to 11.3% (Table 2). There was a significant difference in protein content of the products except for millet and acha. The variation could be due to difference in the protein content of maize, sorghum, millet and acha grains. The fat content was in the range 5.4 to 8.8%. The value for each product was significantly difference (p<0.05) in all the samples. The difference could be due to the difference in fat content of the cereal grains used. The higher fat content of *Dambu* could be attributed to higher content of germ fraction present in the grit flour and it could also result from the added spices. Black pepper alone has a fat content of 7% (Bender, 1990). The high fat content of *Dambu* could lead to rancidity of the product, but oleoresin content of the incorporated spices could provide inhibition of oxidative rancidity (Giese, 1993). The carbohydrate content of the *Dambu* fall within the range 46.8 to 53 3% (Table 2). There was no significant difference (p>0.05) in carbohydrate content for all the products.

Sensory quality of *Dambu* made from maize, millet, sorghum and acha grains: The mean score for the sensory evaluation of the different *Dambu* products are shown on Table 3. The texture of DAC was significantly different (p<0.05) from those of other *Dambu* products. This could be due to the fine texture of milled acha flour as compared to the coarse texture of the other grains used in the product formulation. The mean scores of colour for the four *Dambu* products were not significantly different. This could be due to the similar method of processing the cereal grains into *Dambu*. There was no significant difference in the odour, taste and overall acceptability of the four products irrespective of the grain used. Any of the cereal grains could be used to substitute the other when a particular grain is not available. Acha food is recommended by some physicians in Nigeria for diabetic patients (Jideani, 1999). It is consumed as whole grain and therefore may make for small increase in blood glucose level (Gopalan, 1981). The cereal grains used in production were deodourized by steaming. Therefore, the uniformity in the taste of *Dambu* was attributed to uniformity in processing of the products. The general acceptability could also be attributed to the fact that the raw materials used were from the same grass family.

Storage quality of *Dambu*: The result of storage study of the different *Dambu* products as measured by pH and titratable acidity (TTA) is shown in Fig. 3. There was a gradual decrease in the pH values of all *Dambu* products as the storage time increased while the values for TTA gradually increased. Both parameters signified the presence of acid in *Dambu* (Frazier and Westhoff, 1978). The increase in acid was due to the action of yeasts and lactic acid bacteria which grow best over the pH range 3.0-6.0 (Frazier and Westhoff, 1978). The action of these microbes in lowering the pH could be due to improper packaging and storage condition of the product.

The high value of TTA in respect to phytate indicated the extent to which the glyceride in the oil has been decomposed by lipase (Todd, 1989). The enzymatic action of lipase continued with storage. This implied that the storage condition of *Dambu* is very important for it to remain wholesome.

Table 4: Bacteria load of *Dambu* under different storage conditions[a]

	Days in Refrigerator					Days in Cupboard				Days in Laboratory shelf			
Sample	0	1	2	3	4	1	2	3	4	1	2	3	4
DMA	NG	4.6×10^5	1.0×10^6	1.2×10^6	1.5×10^6	1.4×10^6	2.5×10^6	4.9×10^6	7.0×10^6	2.7×10^6	5.6×10^6	7.5×10^6	9.6×10^6
DMI	NG	6.4×10^5	1.5×10^6	1.5×10^6	1.7×10^6	2.3×10^6	4.7×10^6	6.5×10^6	8.5×10^6	1.2×10^6	7.0×10^6	6.9×10^6	1.2×10^8
DSO	NG	4.0×10^5	9.0×10^5	1.0×10^6	1.2×10^6	1.7×10^6	3.5×10^6	5.0×10^6	6.5×10^6	1.3×10^6	8.5×10^6	7.3×10^7	1.2×10^8
DAC	NG	3.1×10^5	7.0×10^5	7.9×10^5	9.0×10^5	2.2×10^6	4.5×10^6	6.1×10^6	7.9×10^6	3.1×10^6	6.9×10^6	7.8×10^6	9.5×10^6

[a]*Dambu* made from maize (DMA), millet (DMI), sorghum (DSO) and acha (DAC), Day zero (0) is the freshly prepared *Dambu* analyzed 3 h after production, At zero day there was no growth at the different storage conditons (Refrigeration, cupboard and laboratory shelf), NG = No growth. Values are in cfu/g

Table 5: Mould and yeast count of *Dambu* under different storage conditions

	Days in Refrigerator					Days in Cupboard				Days in Laboratory shelf			
Sample	0	1	2	3	4	1	2	3	4	1	2	3	4
DMA	NG	4.0×10^5	9.0×10^5	1.0×10^6	1.2×10^6	1.7×10^6	3.5×10^6	4.9×10^6	6.5×10^6	2.4×10^6	5.0×10^6	6.6×10^6	8.5×10^6
DMI	NG	3.5×10^5	8.0×10^5	9.1×10^5	1.1×10^6	1.5×10^6	3.5×10^6	3.8×10^6	4.5×10^6	2.1×10^6	4.3×10^6	6.3×10^6	8.4×10^6
DSO	NG	3.5×10^5	8.0×10^5	8.5×10^5	1.0×10^6	1.6×10^6	3.5×10^6	4.4×10^6	5.5×10^6	2.8×10^6	6.0×10^6	7.5×10^6	9.5×10^6
DAC	NG	2.3×10^5	5.0×10^5	6.3×10^5	8.0×10^5	2.1×10^6	4.9×10^6	5.1×10^6	5.9×10^6	2.9×10^6	6.9×10^6	6.7×10^6	7.5×10^6

[a]*Dambu* made from maize (DMA), millet (DMI), sorghum (DSO) and acha (DAC). Day zero (0) is the freshly prepared *Dambu* analyzed 3 h after production, At zero day there was no growth at the different storage conditons (Refrigeration, cupboard and laboratory shelf). NG = No growth, Values are in cfu/g

Microbial quality of *Dambu* under different storage conditions: The microbial quality of *Dambu* under different storage conditions is shown on Table 4 and 5. There was no growth on the freshly prepared samples stored in the refrigerator, laboratory shelf and cupboard. The absence of growth could be attributed to high temperature used in steaming and also the spices used that may have inhibited microbial growth. However, after 24 h of production, the microbial load of *Dambu* under the various storage conditions increased with time for each product. The microbial load continued to increase for each product after 72 h of production. The *Dambu* stored on the laboratory shelf had the highest microbial load of 1.2×10^8 for bacteria and 9.5×10^6 for yeast and mould. This could be due to the ambient temperature that supported the growth of most micro-organisms. Since storage was in an open environment without the addition of preservative or a packaging material to prevent microbial contamination, the air micro-organisms could have contaminated the food products. The *Dambu* stored in the laboratory cupboard showed a lesser microbial load. This could be because the products were excluded from light and the open environment. However, the microbial load after 48 h for products stored in the laboratory cupboard and shelf were high compared to the acceptable limit for cereal products. It is known that aerobic plate count values for cereal products exceeding 10^6 cfu/g are considered microbiologically unsafe (FAO, 1979). The *Dambu* stored under refrigeration showed the least growth throughout the four days storage period when compared with the products stored in the laboratory cupboard and shelf. The present result agrees with the fact that the shelf life of perishable foods could be prolonged with the use of low temperature preservation.

Conclusions: Investigation into the physicochemical and microbial properties of *Dambu* showed that *Dambu* is a nutritive staple food. Its protein, fat and ash content are high enough making *Dambu* nutritionally better than the cereal grain from which it is produced. In terms of sensory qualities, *Dambu* made from acha grain was less preferred in texture than those from other cereal grains. However, any of the four cereal grains can be used for *Dambu* production. *Dambu* being a perishable food product cannot stay more than 24 h without microbial spoilage when stored in the laboratory cupboard and shelf. Storage under refrigeration seems to prolong the shelf life of *Dambu* than the other two storage conditions.

References

Akingbala, J.O., I.A. Adeyemi, S.O. Sangodoyin and O.L. Oke, 1994. Evaluation of amaranth grain for ogi manufacture. Plant Foods Hum. Nutr., 46: 19-26.

Ayo, J.A., 2001. The effect of amaranth grain flour on the quality of bread. Int. J. Food Properties, 4: 341-351.

Bender, A.E., 1990. Dictionary of Nutrition and Food Technology 6th Edn New York: Macmillan Publisher, pp: 30-31.

Buchanans, R.E. and N.E. Gibbons, 1974. Bergey's Manual of Determinative Bacteriology, 8th Edn. Baltimore: Williams and Wilkins Company.

Cheftel, J.C., J.L. Urig and D. Loveint, 1989. Amino acid peptide and protein in food chemistry. Fennema, O.R. Ed Food Science and Technology, New York: Marcel Dekker, pp: 282-285.

Collins, H. and P.M. Lyne, 1987. Microbiological Method 5th Edn. London: Butterworths and Co. Publisher Ltd., pp: 97-147.

Egan, H., R.S. Kirk and R.J. Sawyer, 1981. Pearson's Chemical Analysis of Food 8th Edn. London: Churchill Living Stone Publisher, pp: 446-469.

FAO, 1979. Food and Nutrition paper 14/4. Manuals of food quality control 4 (Microbiological analysis). FAO, Rome, Italy.

Frazier, W.C. and D.C. Westhoff, 1978. Food Microbiology 3rd Edn. New Delhi, McGraw-Hill Publishing Co. Ltd.

Giese, J., 1993. Spices and seasoning blends a taste for all seasoning. J. Food Technol., 49: 88-98.

Gopalan, C., 1981. Carbohydrate in diet. Bull. Nutr. Found, India.

Hulse, J.H., E.M. Laing and O.E. Pearson, 1980. Sorghum and the millets: their composition and nutritive value. Int. Dev. Centre. New York, Ottawa, Canada. Academic Press.

Ihekoronye, A.I. and P.O. Ngoddy, 1985. Integrated Food Science and Technology for the Tropics. London. Macmillan Publishers Ltd., pp: 345-360.

Jideani, I.A., 1999. Traditional and possible technological uses of *Digitaria exilis* (acha) and *Digitaria iburu* (iburu): A review. Plant Foods Hum. Nutr., 54: 363-374.

Jideani, V.A., I. Nkama, E.B. Agbo and I.A. Jideani, 2001. Survey of Fura Production in some Northern States of Nigeria. Plant Foods Hum. Nutr., 56: 23-26.

Kent, W.L., 1983. Technology of Cereal. Pergamon, Headington Hill Hall, Oxford UK, pp: 49-60.

Nkama, I., I.A. Angarawai and M.H. Badau, 1999. Survey report on Food Technology of Millet. Lake Chad Research Institute Maiduguri, Nigeria, pp: 53.

Todd, E.C.P., 1989. Foodborne disease in Canada and cost to reduce Salmonellosis. J. Food Protect, 52: 594.