British Journal of Applied Science & Technology
4(32): 4558-4565, 2014
ISSN: 2231-0843

SCIENCEDOMAIN *international*
www.sciencedomain.org

Evaluation of Nutritional and Microbial Quality of Three Varieties of Dankuwa: A Nigerian Cereal Snack

K. S. Okeke[1*], Z. A. Bello[1] and O. Akoma[2]

[1]Department of Nutrition and Dietetics, Federal Polytechnic Bida, Niger State, Nigeria.
[2]Department of Science Laboratory Technology, Federal Polytechnic Bida, Niger State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author KSO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors OA and KSO supervised the work. Author ZAB managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2014/11857
Editor(s):
(1) Ya-mei Gao, College of Life Science and Technology, Heilongjiang Bayi Agariculture University, Daqing, Heilongjiang, China.
Reviewers:
(1) Monika Kocková, Department of Nutrition and Food Assessment, Institute of Biochemistry, Nutrition and Health Protection, Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava, Slovakia.
(2) Yiannis Kourkoutas, Department of Molecular Biology & Genetics, Democritus University of Thrace, Greece.
(3) Anonymous, Obafemi Awolowo University, Nigeria.
(4) Anonymous, Research Center for Food and Development, Mexico.
(5) Anonymous, Central Michigan University, USA.
Peer review History: http://www.sciencedomain.org/review-history.php?iid=659&id=5&aid=6108

Original Research Article

Received 6th June 2014
Accepted 30th July 2014
Published 16th September 2014

ABSTRACT

Aims: This study addresses the issue of diversification of dankuwa in order to increase its nutritional quality and to determine the nutritional and microbial load of dankuwa sold by vendors and laboratory produced dankuwa.

**Corresponding author: E-mail: susanokeke@gmail.com;*

Study Design: To produce dankuwa using other cereal such as millet and sorghum and to determine the nutritional content, sensory properties and microbial load of commercial dankuwa and laboratory produced dankuwa.
Place and Duration of Study: Samples were purchased from vendors in Bida Local Government, Nigeria. Analyze at Central Services Laboratory of National Cereal Research Institute, Badeggi, Niger State. Experiment was conducted between November 2013 and March 2014.
Methodology: In this study, three samples of dankuwa cereal were used. Two samples were laboratory processed using sorghum or millet and the third sample was purchased from vendors. The various dankuwa samples were analysed to determine their nutritional quality, sensory properties and microbial properties at Central Services Laboratory of National Cereal Research Institute Badeggi, Bida Niger State. Results obtained were subjected to statistical analysis.
Results: The proximate content of the dankuwa was evaluated in this study revealed that the crude fat (20.38%) of the locally produced dankuwa (maize + groundnut) did not differ ($p>.05$) from the laboratory produced dankuwa using millet + groundnut (20.38%). Generally, the dankuwa produced locally differed significantly ($p<.05$) from those produced using millet and sorghum in appearance, sweetness and overall acceptability as well as their microbial load. The microorganisms isolated from the products were *Staphylococcus aureus, Bacillus spp, E. coli, Pseudomonas spp, Micrococcus spp, Aspergillus niger, Aspergillus flavus, Mucor spp, Rhizopus spp, Rhizopus spp and Penicillum spp.*
Conclusion: The use of other cereal such as sorghum and millet increases the crude protein content of dankuwa as well as attract overall acceptability or preference by panellists.

Keywords: Cereal snack (dankuwa); nutritional analysis; sensory quality; microbial assessment.

1. INTRODUCTION

Dankuwa is a traditional ready-to-eat Nigerian cereal based snack. It is made by mixing flour of roasted maize and groundnut with spices like dried alligator pepper, sugar and salt. The mixture is then moulded into small balls that can be eaten without further processing [1,2]. Dankuwa is mostly consumed in different parts of Nigeria and other Africa countries as snack by both the young and elderly.

Dankuwa similar to most cereal-based foods is rich in complex carbohydrate and low in fat and protein [3,4]. Most producers of dankuwa prefer using maize in production of dankuwa because it easy to cultivate, gives larger yield and easily stored [2]. The present practice where small quantities of roasted groundnut are added to large amount of maize grains as flour enhancers does not imply that dankuwa is nutritionally supplemented. This is because the quantities of the groundnut added are too small to make significant impact on the nutritional quality of the products. In order to enrich the product nutritionally and also provide another recipe for its production there is a need to modify its production process by using other cereals like millet and sorghum. Presently, the processing and consumption of dankuwa is traditional based rather than scientific practices [5]. This translates to variable quality characteristics [3].

The producers of dankuwa are mostly females who are usually illiterate, bare hands are used for rolling the products into balls; unsterile packaging material (polythene) are used for packing. These practices can lead to contamination of the products, food poisoning and outbreak of foodborn illness which is a major problem of most developing countries such as Nigeria [6].

Information about the production of dankuwa using millet or sorghum is rare. Therefore the objective of this study is to modify the production process of dankuwa using alternative cereals like millet or sorghum and to assess the effects of these on its nutritional, sensory and microbiological quality attributes as compared with those produced and marketed by the local vendors in Bida.

2. MATERIALS AND METHODS

2.1 Sampling Site/Sample Collection

Six balls of dankuwa was purchased from local vendors randomly at Minna Garage in Bida Local Government Area with sterile bottles and immediately transported to Central Services Laboratory of the National Cereal Research Institute Badeggi, Bida Niger State for analysis.

2.2 Laboratory Production of Dankuwa (Cereal Snack) Using Sorghum and Millet

Three hundred grams (300g) of millet or sorghum and 200g of groundnut (3:2) were sorted, winnowed, washed and dried in clean environment. The cereals were roasted separately, winnowed, sorted again while the groundnut was dehusked. This was then milled using locally fabricated electrical milling machine (With the surface sterilized using 5% sodium bisulphite). 10g of dried grounded pepper, 20g of ginger, 90g of sugar, 0.5g of salt and 10ml of water was added to the flour. This was mixed and rolled into balls using sterile gloves.

2.3 Proximate Analysis of Dankuwa Produced In Laboratory (Using Millet & Sorghum) and Dankuwa Purchase from Vendors

Proximate analysis was carried out using standard procedures of the [7]. Moisture content was determined by drying the sample in a vacuum oven at 100ºC and dried to a constant weight (5hrs). Ash content was determined by incinerations of 2g of the sample in a muffle furnace at 600ºC for 8hrs.The percentage residue weight was expressed as ash content. Crude fat was determined by Soxhlet Extraction method using hexane as solvent. Crude protein was determined by microkjeldah. Carbohydrate was determined by difference. Energy content of the maize was determined by multiplying % crude protein, % crude fat, % carbohydrate by 4, 9 and 4 respectively (Kcal/100g) [7].

2.4 Sensory Evaluation of Dankuwa Samples

Sensory evaluation of dankuwa samples was conducted using a 15-member sensory panellist including teachers and students. Degree of acceptance or likeness or preference was expressed (appearance, taste, aroma and overall acceptability) on a 9 point Hedonic scale (where; 1=Dislike extremely, 2=Dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=neither like nor dislike, 6=Like slightly, 7=Like moderately, 8=Like very much,

9=Like extremely). Coded samples were served to panellist with glass of water to rinse their mouth in between the tasting period as described by [8].

2.5 Microbiological Analysis Dankuwa Samples

Twenty five grams of the dankuwa products (using maize, millet and sorghum) was added to 225ml of sterile 0.1% peptone water and homogenize in sterile laboratory blender. 1ml of the homogenate was added to 9ml of 0.1% peptone water (1:10w/v). This was further diluted up to 10^{-5} for bacterial count and 10^{-4} for fungi count. The total viable count of each of the samples was determined using pour plate techniques on nutrient agar in triplicates. Coliform count was determined using Eosin Methyl Blue (EMB) agar while Staphylococcal count was determined on Mannitol agar. Plates were incubated aerobically at 37ºC and colonies that developed were counted and recorded as colony forming unit (cfu/g) after 24-48h. The fungal count was however determined on Potato Dextrose agar plate using pour plate techniques. 4mg of chloramphenicol was added to 100ml of PDA prior to autoclaving. This was incubated at ambient temperature for 6days [9,10].

2.6 Identification of the Microbial Isolates

Identification of enumerated microbes was carried out using growth on diagnostic media, microscopic appearance, morphological and biochemical test as described by [9]. The microbiological test were Gram stain, motility, presence of spores and cell shape while biochemical test included catalase test, coagulase test, methyl red test, Voges proskauer test, gelatin hydrolysis test, urease test, nitrate reduction test, citrate utilization test, hydrogen sulphide production test, Indole test and fermentation of sugars (glucose, sucrose, manitol, fructose, lactose and maltose). The isolates were identified by comparing their characteristics with known taxa as described by [11]. A wet mount of the fungal isolates was done using lactophenol cotton blue and observed under the microscopes. Following the examination of characteristics as well as the back view of the plate culture, the molds where identified as described by [9].

2.7 Statistical Analysis

Analysis of variance (ANOVA) was carried out for nutritional, sensory and microbial analysis. The mean scores were computed and significant difference among the mean was determined (Duncan, p=.05) using 2006 statistical packages for social sciences (SPSS) for windows version 15.0 [12].

3. RESULTS

3.1 Proximate Quality of Dankuwa Produced Using Combination of Groundnut and Maize or Millet or Sorghum

The proximate content of the 3 dankuwas' evaluated in this study is shown in Table 1. The crude fat (20.38%) of the locally produced dankuwa (maize + groundnut) did not differ (p>.05) from the laboratory produced dankuwa using millet + groundnut (20.38%). However these differed (p<.05) from the dankuwa produced using combination of sorghum and groundnut Table 1.

The moisture content, carbohydrate and energy value of the locally produced dankuwa as shown in Table 1 was not significantly different (p>.05) from the dankuwa produce using sorghum and groundnut, but these differed (p<.05) from the dankuwa produced using millet and groundnut. Generally the ash and crude protein content of the 3 products differed (p<.05) significantly but, the dankuwa produced using combination of groundnut and sorghum or millet did not differ (p>.05) in crude fibre but, these differed (p<.05) from the locally produced dankuwa Table 1.

Table 1. Proximate content and energy value of commercially produced dankuwa and laboratory produced dankuwa

Analyses (%)	Products[1,2,3]		
	DV	DS	DMT
Moisture content	1.30±0.02[a]	2.20±0.02[a]	1.53±0.11[b]
Fat content	20.38±0.29[a]	16.68±0.04[b]	20.38±0.08[a]
Crude protein content	11.57±0.1.27[c]	17.03±0.04[b]	19.07±0.74[a]
Crude fibre content	2.70±0.04[a]	1.45±0.01[b]	1.53±0.03[b]
Ash content	1.32±0.01[c]	1.43±0.05[b]	1.51±0.01[a]
Carbohydrate content	66.97±6.21[a]	61.24±0.02[a]	56.70±0.04[b]
Energy value (Kcal/100g)	4.84±4.33[a]	4.64±0.39[a]	4.35±7.56[b]

[1]Each value is the mean±S.E of 3 determinations
[2]Different letters within the same row are significantly different (p<.05)
[3]DV=Dankuwa purchase from vendors produced using maize/ groundnut, DS=Dankuwa produced in laboratory using sorghum /ground nut, DMT= Dankuwa produced in laboratory using millet/ groundnut

3.2 Sensory Quality Characterisation of Dankuwa Produced Using Combination of Groundnut and Maize or Millet or Sorghum

As shown in Table 2, the sensory quality characteristics of the 3 dankuwa products as evaluated in this study showed that there were no significant difference (p>.05) in texture (7.13,7.93,7.07). However, difference were observed in the aroma (p<.05) of the 3 products. Generally, the dankuwa produced locally differed significantly (p<.05) from those produced using millet and sorghum in appearance, sweetness and overall acceptability Table 2.

Table 2. Sensory quality attributes of commercially produced dankuwa and laboratory produced dankuwa

Analyses	Products[1,2,3]		
	DV	DS	DMT
Aroma	5.47±0.80[c]	7.13±0.31[a]	6.47±0.31[b]
Appeareance	5.87±0.36[b]	6.93±0.25[a]	6.93±0.37[a]
Texture	7.13±0.52[a]	7.93±0.36[a]	7.07±0.50[a]
Sweetness	6.67±0.47[b]	8.27±0.12[a]	8.00±0.01[a]
Overall acceptability	6.07±0.36[b]	8.00±0.22[a]	7.53±0.27[a]

[1]Each value is the mean±S.E of 15 member panellist (hedonic score:- where 1=Dislike extremely, 5= neither like nor dislike, 9= like extremely
[2]Different letters within the same row are significantly different (p<.05)
[3]DV=Dankuwa purchase from vendors produced using maize/ groundnut, DS=Dankuwa produced in laboratory using sorghum /ground nut, DMT= Dankuwa produced in laboratory using millet/ groundnut

3.3 Microbiological Qualities of Dankuwa Produced Using Combination of Groundnut and Maize or Millet or Sorghum

The microbial load of the 3 danku was as shown in Table 3, showed that the total viable, Staphylococcal and fungal counts (cfu/g) were significantly different ($p<.05$) with the locally produced dankuwa showing the highest counts $1.47x10^6$, $3.00x10^3$ and $4.00x10^5$ respectively. However, the coliform count of the dankuwa purchased from the local vendors $7.90x10^4$ differ ($p<.05$) from the rest $4.20x10^1$ and $4.50x10^1$ Table 3. The microorganisms isolated from the products were *Staphylococcus aureus, Bacillus spp, E. coli, Pseudomonas spp, Micrococcus spp, Aspergillus niger, Aspergillus flavus, Mucor spp, Rhizopus spp, Rhizopus spp and Penicillum spp.*

Table 3. Microbiological quality of commercially produced dankuwa and laboratory produced dankuwa

Analyses	Products[1,2,3,4]		
	DV	DS	DMT
Total viable count	$1.47x10^{6}\pm3.33x10^{4a}$	$7.13x10^{3}\pm2.33x10^{2c}$	$1.53x10^{3}\pm6.66x\ 10^{2b}$
Coliform count	$7.90x10^{4}\pm1.53x10^{3a}$	$4.20x10^{1}\pm1.16x10^{1b}$	$4.50x10^{1}\pm1.73x10^{1b}$
Staphylococcal count	$3.00x10^{3}\pm0.01^{a}$	$1.37x10^{1}\pm0.33^{b}$	$1.17x10^{1}\pm0.88^{c}$
Fungal count	$4.00x10^{5}\pm1.16x10^{4a}$	$9.30x10^{1}\pm1.73x10^{1b}$	$4.23x10^{1}\pm1.45x10^{1c}$

[1]Each value is the mean±S.E of 3 determinations
[2]Different letters within the same row are significantly different (p<.05)
[3]DV=Dankuwa purchase from vendors produced using maize/ groundnut, DS=Dankuwa produced in laboratory using sorghum /ground nut, DMT= Dankuwa produced in laboratory using millet/groundnut
[4]Microbial isolates from DV includes; Staphylococcus aureus, Bacillus spp, E. coli, Pseudomonas spp, Micrococcus spp, Aspergillus niger, Aspergillus flavus, Mucor spp, and Rhizopus spp, while DS/DMT microbial isolates includes; Micrococcus spp, Rhizopus spp, Mucor and Bacillus spp

4. DISCUSSION

The result of this study showed that the dankuwa hawked by Vendors in Bida had high carbohydrate and fat content. This may be as a result of the high quantity of maize added instead of putting enough groundnuts to enrich the product. The producers usually add some groundnut oil to bring out the groundnut flavour without the consumer knowing. All these are carried out in order for the Vendors to maximise profit. According to [13], high fat content in snacks could be as a result of cooking the processing technique which generally involved addition of cooking oil which agrees with the findings of this study. Also, the dankuwa produced using millet as the cereal was observed to have high protein content (19.7%) when compared with other products Table 1. It has been reported by other workers that millet protein are richer sources of essential amino acids [14], the findings of this study further confirms this observation.

Generally, the sensory quality attributes of the cereal snacks (dankuwa) produced from millet and sorghum were more preferred in appearance, texture, sweetness and aroma to the dankuwa produced from maize. This distinct sensory quality may be attributed to the high nutritional quality of millet and sorghum as compared with maize Tables 1, 2.

Furthermore, this study revealed that dankuwa purchased from vendors had higher total viable count ($1.47x10^6$cfu/g). This high count is unacceptable as it exceeded the

recommended standard $<10^5$cfu/g for ready-to-eat-food [15,16]. This may indicate unhygienic practises of the producers during production of dankuwa and this should be of great concern to health authority. It is likely that the high count may be due to the contamination from contaminated sieves and local mortars used by these producers during production. The use of spices such as dried pepper usually added to dankuwa to improve its taste and aroma may have contributed to the heavy contamination. This was also reported by [17]. The Staphylococcal count obtained from the dankuwa produced from maize by the Vendors was also unacceptable as it exceeded $<10^5$cfu/g [15,16]. The high counts may be attributed to the fact that these producers use their bare to roll the products into balls. Although, part of dankuwa production process is the application of heat, a process that would have eliminated all microflora except heat resistant organisms and spore formers. The presence *of Staphylococcus aureus, Bacillus spp, E. coli and Aspergillus flavus and Aspergillus niger* in the dankuwa produce using maize thus suggest that the product must have been contaminated after roasting process or during the rolling of the dankuwa. The presence of *Aspergillus flavus* may be hazardous to public health. *Aspergillus flavus* has been implicated in hepatoxicity and cancer in mammals including man [18]. The low bacterial and fungal count observed in the laboratory prepared dankuwa may be due to better hygienic practises during production.

5. CONCLUSION

This study revealed that dankuwa sold by vendors are unsatisfactory as it microbial load exceeded the regulated limit for Ready-to-eat food. The high fungal contamination in hawked dankuwa is alarming, this should be of great concern to health authority as these pose serious public health problems to human. The use of other cereal such as sorghum and millet increases the crude protein content of dankuwa as well as attract overall acceptability or preference by panellists.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ocheme BC, Chukuma CA, Emmanuel KI. Moisture, absorption characteristics of Dankuwa (Nigerian cereal/groundnut snack. International Journal of Food Engineering. 2013;0(0):1-6
2. Oguntunde AO. Traditional convenience food from major Nigeria cereal grains. Nigeria Food Journal. 1998;58-66
3. Ingbian EK, Akpapunam MA. Appraisal of traditional technologies in the processing and ultilization of Mumu-a cereal based local food product. Afri J of Food Agric Nut & Dev. Rural Outreach Program. 2005;11:2.
4. Omueti O, Morton IO. Development, acceptability, nutrition and physical characteristics of protein improved Nigeria Abari (maize meal) prepared from soya and maize flours. Int J of Food and Nut. 1996;47(5):369-375.
5. Abdulrahaman AA, Kolawole OM. Traditional preparations and uses of maize in Nigeria. Ethnobotanical Leaflet. 2006;10:219-227.
6. Gadaga TH, Nyanga LK, Mutukumira. The occurrence, growth and control of pathogens in African fermented foods. Afri J Food Agriculture Nutrition and Development Rural Outreach Program. 2004;4(1):1684-5374.

7. AOAC. Official Methods of Analysis, Association of Analytical Chemists 15th ed., Washington D.C.; 1990.
8. Larmond E. Laboratory methods for sensory evaluation of food. Canada Department of Agriculture, Ottawa, Canada; 1982.
9. 9 Harrigan WF, McCance ME. Laboratory methods in foods and dairy microbiology. Academic Press, London. 1976;39-88.
10. Sneath PH, Matr NS, Sharp ME, Holt JG. Bergey's manual of systemic bacteriology. Baltimore William and Wilkin. 1986;2.
11. Cruickshank R, Duguid JP, Marimion BP, Swain RHA. Medical microbiology (12th ed). Churchill Livingstone, London. 1975;137.
12. SPSS. Statistical Package for Social Sciences for Windows (version15.0); 2006. Available: http://www.spss.com.
13. Alector O, Ojelabi A. Comparative evaluation of the nutritive and functional attributes of some traditional Nigerian snacks and oil seed cakes. Pakistian J of Nut. 2007;6(1):99-103.
14. Ahmed SMS, Qing Z, Jing C, Qun S. Nutritional quality, processing and potential health benefits. Comprehensive Reviews in Food Science and Food. 2013;12(3):281-295.
15. HPS (Health Protection Agency) Guidelines for Assessing the Microbiological Safety of Ready to Eat Foods; 2009.
16. (CFS) Centre for food Safety. Microbiological Guidelines for Ready-to-Eat-Food. (Food and Environmental hygiene).; 2007.
17. Adeyemi T, Umar S. Effect of manufacture on the quality characteristics of kunun zaki: A millet based beverage. Niger Food Journal. 1994;12:34-40.
18. Okeke KS, Abdullahi. IO, Makun HO, Mailafiya SC. A preliminary survey of Aflatoxin M_1 in dairy cattle products in Bida, Niger State, Nigeria. Afri J Food Sci Tech. 2012;3(10):273-276.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=659&id=5&aid=6108