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Production and Evaluation of Tigernut (*Cyperus esculentus*) Milk Flavoured with *Moringa oleifera* Leaf Extract

ABIODUN OMOWONUOLA ADEBAYO - OYETORO,[1]* OLADEINDE OLATUNDE OGUNDIPE,[1] SAMUEL AYOFEMI OLALEKAN ADEYEYE,[2] EMMANUEL ADEDAPO AKANDE[3] and ABIOLA BUSOLA AKINYELE[1]

[1] Department of Food Technology, Yaba College of Technology, P.M.B. 2011, Yaba, Lagos, Nigeria.
[2]Department for Management of Science and Technology Development, Ton DucThang University, Ho Chi Minh City, Vietnam.
[3] Department of Food Science and Engineering, Ladoke Akintola University of Technology, P.M.B 4000, Ogbomoso, Oyo State, Nigeria.

Abstract

Recently, research focus is on phyto - plants with their health benefits. This study therefore was carried out to produce and evaluate quality and acceptability of tigernut milk flavoured with *Moringa oleifera* leaf extract. Milk was prepared from tigernut and blended with *Moringa* extract in ratios 95 : 5, 90 : 10 and 85 : 15 respectively while 100 % tigernut milk was used as control. Samples were coded as NOD, MDA, JNJ and ABD respectively. Proximate composition, emulsification, total titratable acidity (TTA), pH and sensory analysis were carried out on the samples. Results showed that sample JNJ had the highest percentages of carbohydrate and protein of 4.33 + 0.02% and 2.34 + 0.02% respectively, ABD had the highest percentages of lipid, ash and emulsifying property of 2.54 + 0.02%, 0.028 + 0.01% and 444 + 4.24 mg/100g respectively. The pH of all samples varies between 7.13 and 7.24. Sensory evaluation showed that sample NOD was the most acceptable. Most of the parameters measured are significantly different ($p < 0.05$). This study concluded that sample NOD could be produced for consumption and will be acceptable by the consumers. The higher the amount of *Moringa oleifera* leaf extract added to the imitation milk the better the health benefit it offers. This is because sample JNJ (85 : 15 tigernut - moring) has the highest amount of protein and minerals when assessed).

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CONTACT Abiodun Omowonuola Adebayo - Oyetoro abiodun.oyetoro@yabatech.edu.ng Department of Food Technology, Yaba College of Technology, P.M.B. 2011, Yaba, Lagos, Nigeria.

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Introduction

In recent years, increased awareness of the health and well being of people globally have necessitated the partial switch from animal-based food products to natural and health foods with nutrient balanced profile required for various metabolic, physiological and other functional demands (Panghal *et al.*, 2009, Panghal *et al.*, 2018).

Plant foods are very essential to man's health and survival due to the presence of protein and carbohydrate of about 70% and 80% respectively (Panghal *et al.*, 2006). In addition to this, fruits and vegetable are important plant foods rich in essential vitamins and minerals but are known to have short shelf life due to high susceptibility to physiological breakdown postharvest. To this end, there is need for rapid processing either into shelf-stable or entirely new product to enhance their shelf life as well as value addition (Panghal *et al.*, 2017).

Tigernut (*Cyperus esculentus*) is a crop of the sedge family widespread across much of the world. It is an underutilized crop which belongs to the division-Magnoliophyta, Classiliopcida, order - Cyperales and family - Cyperaces (family). It is found in most of the Eastern Hemisphere, including Southern Europe, Africa and Madagascar, as well as the Middle East and the Indian subcontinent and of the same genus as the papyrus plant (Belewu and Belewu, 2007). It is called earth almond, *zulu* nut. It is known in Nigeria as *Aya* in Hausa, *ofio* in Yoruba and *Akiausa* in Igbo. It has three varieties (black, brown and yellow). The yellow variety is preferred because it yields more milk upon extraction, contains lower fat, less anti-nutritional factors especially polyphenols and more protein (Okafor *et al.*, 2003).

The tigernut milk is very nutritive and it serves as a source of energy for all categories of people. The nut can be eaten raw, roasted, dried or baked. It is a good source of starch, glucose, protein and minerals such as potassium, phosphorus, vitamin E and C. The tigernut milk fat contains a large amount of oleic acid which is heart friendly and helps to prevent cardiac arrest. It also aids the internal mechanisms and prevents both constipation and diarrhea. (Bamishaiye and Bamishaiye, 2011; Asante, 2014)

All parts of the plant are useful and could be used as medicinal plant, vegetable, animal fodder and a source of vegetable oil (Oliveira *et al.*,1999). The leaves have been reported to havehypo-cholesterolemic effect (Ghasi *et al.*, 2000), hepato-protective (Pari and Kumar 2002, Fakurazi and others 2008), antimicrobial (Caceres *et al.*,1991) and gastric antiulcer effect (Dahiru *et al.*,2006).

The aim of this study is to evaluate the quality and acceptability of tigernut milk flavoured with *Moringa oleifera* leaf extract due to the health benefits of *Moringa oleifera* which has been shown to have crude protein 30%, potassium 1209.67 mg/Kg, iron 26.83 mg/Kg and calcium 1880mg/Kg (Asante, 2014).

Materials and Methods

Sources of Materials

Yellow tigernut (*Cyperus esculentus*) (4Kg) was obtained from a market in Badagry Local Government Area of Lagos State, Nigeria, and transported to the Food Technology laboratory, Yaba College of Technology, Yaba, Lagos State Nigeria, in a thick polyethylene bag for processing. These were divided into four batches of 1kg each. *Moringa oleifera* leaves (2Kg) which were healthy and uninfected were obtained from the college campus and taken to the laboratory same day. The leaves were washed under running tap to remove dust and other foreign particles.

Production of Tigernut Imitation Milk and *Moringa oleifera* Extract

The imitation milk from tigernut was produced by modifying the method of Adgidzi *et al.*,(2011). The batches of fresh tiger nut samples were cleaned and soaked in cold water for 24hrs, wet milled with about two litres per kilogram of water, using a clean sterilized blender. This was followed by filtration using muslin cloth to remove the chaff from the milk.

Fresh leaves of *Moringa oleifera* (1Kg) was boiled with 1.5 litres of water for 15 mins at 80 ^{0}C, after which it was cooled. The extract was separated using sterile muslin cloth and filter through sterile Whatman filter paper.

Production of Tigernut - *Moringa oleifera* Milk

After the production of milk and *moringa* extract, different blending ratios of 95 ml of tigernut milk to 5ml of *moringa* extract, 90ml of tigernut milk to 10ml of *moringa* extract, 85ml of tigernut milk to 15ml of *moringa* extract were produced while 100ml of tigernut milk was prepared as control. These samples were coded NOD, MDA, JNJ and ABD respectively.

Proximate Analysis

The moisture content, fat, protein, crude fibre and crude ash of the samples were determined using the methods of AOAC (2005) while carbohydrate was calculated by difference as highlighted by AOAC (2005) as; % carbohydrate = 100 % - % (moisture + protein + fat + fibre + ash).

Titratable Acidity, pH and Emulsification Property.

Titratable acidity and pH were determined by the methods of Nout *et al*. (1989). A standardized pH meter (OHAUS, Starter 2000) was used to determine the pH after it has been standardized with buffer at pH 4 and 7. Mineral elements (Ca, Mg, K, Na) were estimated as described by Fernandez (2002) using Atomic Absorption Spectrophotometer (A. Analyst 700, Perkin Elmer, USA) equipped with standard burner air-acetylene flame and hollow cathode lamps, as radiation source. Emulsification capacity was determined using the modified method of AOAC (2000).

Sensory Evaluation

Samples were assessed for colour, flavour, taste, aroma and overall acceptability using a 20 - member semi - trained panelists on 9 - point hedonic scale with (9) = extremely like and (1) = extremely dislike. The samples were presented to the panelists using white glass cups. This was as described by Larmond (1977).

Statistical Analysis

The mean scores were analyzed using analysis of variance (ANOVA) and differences separated using Duncan test. SPSS 15.0 software package was used to run the analysis.

Results and Discussion

The results of the proximate analysis of the samples were shown on Table 1. The results showed that the carbohydrate and protein contents were highest in sample JNJ (85:15 tigernut - *moringa*) and lowest in ABD (control sample) and MDA (90:10 tigernut - *moringa*) respectively. Lipid, moisture and crude ash contents were highest in sample ABD and lowest in sample MDA and JNJ respectively while crude fibre was highest in sample MDA and lowest in sample ABD. All the samples analysed generally have high carbohydrate contents with the values ranging between 2.07 - 4.33%. The highest carbohydrate content in sample JNJ was due to high carbohydrate content of tigernut milk and *moringa* extract.

Tigernut milk has been reported to be used in the treatment of flatulence, indigestion, diarrhea and dysentery due to its carbohydrate content (Bixquert -Jimenez, 2003). In addition, starch content of this product has been reported to provide probiotic properties for colon bacteria (Alegria - Toranand

Table 1: Proximate Analysis of Tigernut milk Flavoured with *Moringa oleifera* Leaf Extract

Sample codes	Carbohydrate (%)	Protein (%)	Lipid (%)	Moisture (%)	Crude ash (%)	Crude fibre (%)
NOD	3.60+0.06b	2.29+0.021a	1.96+0.014b	91.17+0.21b	0.26+0.00a	0.73+0.14b
MDA	2.61+0.18c	2.10+0.06a	1.65+0.02c	92.28+0.09a	0.21+0.01a	1.17+0.304a
JNJ	4.33+0.02a	2.34+0.02a	1.68+0.01c	91.07+0.16b	0.20+0.00a	0.41+0.21c
ABD	2.07+0.01c	2.11+0.01a	2.54+0.02a	92.90+0.02a	0.28+0.02a	0.12+0.01d

[1]Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)

[2]Sample codes:NOD=95:5 (tigernut milk: *Moringa* extract), MDA=90:10 (tigernut milk: *Moringa* extract), JNJ=85:15 (tigernut milk: *Moringa* extract) and ABD=100% (tigernut milk)

Table 2: pH, TitratableAcidity and Emulsifying Properties of the Samples

Sample codes	pH	Titratable acidity (%)	Emulsifying property mg/100ml
NOD	7.22+0.01a	0.16+0.04b	343.0+2.83c
MDA	7.18+0.03 a	0.48+0.03a	368.0+1.41b
JNJ	7.13+0.04b	0.48+0.00a	391.5+0.71b
ABD	7.24+0.014a	0.14+0.00b	444.4+ 0.24a

[1]Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)
[2]Sample codes:NOD=95:5 (tigernut milk: *Moringa* extract), MDA=90:10 (tigernut milk: *Moringa* extract), JNJ=85:15 (tigernut milk: *Moringa* extract) and ABD=100% (tigernut milk)

Farre-Rovira, 2003). The high amount of protein in sample JNJ could be due to high amino acids in both tigernut milk and *Moringa oleifera* leaves. The high content of lipid in the control sample could be as a result of the high unsaturated fatty acid content of tigernut milk, similar to that of olive oil as reported by Sanchez - Zapata *et al.* (2012). The product required cold storage to prevent deterioration due to its high moisture and fat content. There were significant differences in the proximate composition measured except for protein and ash.

The results of pH and total titratable acidity (TTA) are shown in Table 2. It was observed that sample ABD has the highest pH (7.24) and lowest TTA while sample JNJ has the lowest pH (7.13) and sample MDA has the highest TTA (0.48). These pH values were within neutrality and were similar to

Table 3: Mineral Content of Tigernut Milk Flavoured with *Moringa oleifera* Leaf Extract

Sample codes	Mg (mg/100g)	K (mg/100g)	P (mg/100g)	Na (mg/100g)	Ca (mg/100g
NOD	49.36+1.47^{a}	220.04+0.13^{b}	130.67+0.07^{ab}	222.72+6.05^{a}	139.45+4.39^{a}
MDA	48.87+2.79^{b}	217.85+2.02^{b}	129.37+2.86^{b}	220.51+1.41^{b}	138.07+0.69^{b}
JNJ	49.50+0.22^{a}	220.66+3.98^{b}	131.04+5.68^{a}	223.35+3.82^{a}	139.84+6.06^{a}
ABD	49.68+4.47^{c}	221.44+2.09^{a}	131.50+2.89^{a}	224.14+8.47^{a}	140.34+0.98^{a}

[1]Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)
[2]Sample codes: NOD=95:5 (tigernut milk:Moringa extract), MDA=90:10 (tigernut milk: *Moringa* extract), JNJ=85:15 (tigernut milk: *Moringa* extract) and ABD=100% (tigernut milk)

Table 4: Sensory Evaluation of Tigernut Milk Flavoured with *Moringa oleifera* Leaf Extract

Sample codes	Taste	Colour	Flavour	Aroma	Overall acceptability
NOD	5.5b	8.5a	6.0d	6.5d	6.5b
MDA	4.5c	6.5d	4.0b	4.5c	5.0b
JNJ	3.0d	8.0a	2.5c	2.0b	3.5c
ABD	8.5a	7.0b	8.5a	8.0a	9.0 a

[1]Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)
[2]Sample codes:NOD=95:5 (tigernutmilk:Moringa extract), MDA=90:10 (tigernutmilk:Moringa extract), JNJ=85:15 (tigernutmilk:Moringa extract) and ABD=100% (tigernut milk)

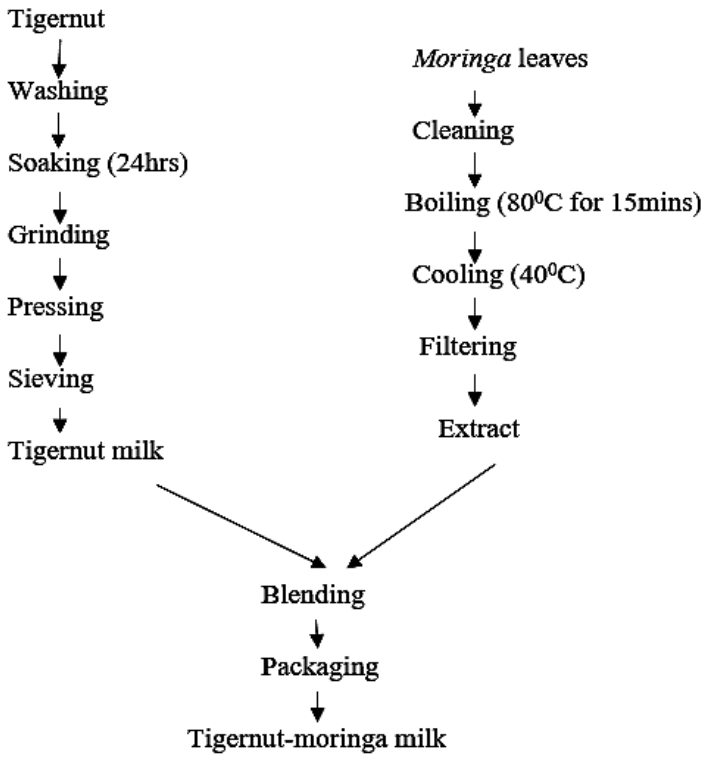

Fig. 1: Flow chart for the production of tigernut milk flavoured with *Moringa oleifera* leaf extract

those reported by Murti *et al*. (1992) and Belewu and Abodunrin (2006). The result of emulsification property showed that sample ABD has the highest emulsification capacity of 444 + 4.24 mg/100g while sample NOD had the lowest value of 343 + 2.83 mg/100g. The study showed significant difference between the samples in terms of pH, TTA and emulsification property.

The results for the mineral content were shown in Table 3. Magnesium, potassium, phosphorus, sodium and calcium were highest in sample ABD, followed by sample JNJ and lowest in sample MDA. Tigernut has been reported to be a very good source of some useful minerals including potassium, phosphorus and calcium (Bixquert - Jimenez, 2003). This result is due to the fact that *moringa oleifera* is also known to be rich source of these minerals (Asante *et al*., 2014)

The results of the sensory evaluation in Table 4 showed that sample NOD has the highest mean values for taste, flavour, aroma and overall acceptability among the test samples when compared with the control sample (ABD).High sensory values obtained for sample ABD maybe due to the familiarity of the panelists with products from tigernut milk. There was no significant difference at ($p < 0.05$) in terms of colour. JNJ has the lowest values in terms of taste, flavour, aroma and overall acceptability. There were significant differences between the control samples and the experimental samples in the sensory parameters evaluated.

The most acceptable blend in terms of sensory evaluation was sample NOD (95:5 tigernut - *moringa*) which had the highest mean scores in the sensory parameters assessed.

Conclusion

In this study, milk from control sample had the highest mineral content while sample JNJ had the highest carbohydrate and protein contents. Sample MDA had the least values for all these parameters measured. It was observed from the study that the experimental samples are significantly different

from the control samples in most of the parameters assessed. Results of the sensory analysis showed that sample NOD was the most acceptable among the experimental samples and the mean values for all the parameters were comparable to the control. This study concluded that sample NOD could be produced for consumption and will be acceptable by the consumers. The higher the amount of *Moringa oleifera* leaf extract added to the imitation milk the better the health benefit it offers. The results from the proximate and mineral composition showed that sample JNJ (85:15 tigernut - *moringa*) has the highest nutrients. This is due to the fact that the sample has the highest amount of *moringa oleifera* which in addition to tigernut is a rich source of protein, digestible carbohydrate and minerals.

Conflict of Interest

Authors declare that no conflict of interest.

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