British Microbiology Research Journal
3(1): 1-18, 2013

SCIENCEDOMAIN ***international***
www.sciencedomain.org

SCIENCEDOMAIN

Comparative Studies on *Citrullus vulgaris*, *Citrullus colocynthis* and *Cucumeropsis mannii* for Ogiri Production

B. J. Akinyele[1*] and O. S. Oloruntoba[1]

[1]*Department of Microbiology, Federal University of Technology, P.M.B 704, Akure, Nigeria.*

Authors' contributions

This work was carried out in collaboration between both authors. Author BJA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author OSO managed the analyses of the study and the literature searches. The both authors read and approved the final manuscript.

Research Article

Received 17th October 2012
Accepted 28th December 2012
Published 5th February 2013

ABSTRACT

Aim: This study investigated the microbiological, physicochemical and antinutritional properties of three varieties of fermenting melon seeds namely: *Citrullus vulgaris (Schrad), Citrullus colocynthis (L)* and *Cucumeropsis mannii* (Naud) for ogiri production.
Methodology: Ogiri was produced from these three varieties of melon seeds following the traditional fermentation process while online monitoring was used to evaluate microbial hazards using standard microbiological techniques. Physicochemical and antinutritional properties were determined using standard methods.
Results: Bacterial counts ranged from 7.0×10^3 cfu/g to 2.4×10^4 cfu/g for *Citrullus vulgaris,* 3.2×10^5 cfu/g to 3.7×10^5 cfu/g for *Citrullus colocynthis* and 8.7×10^6 cfu/g to 9.1×10^6 cfu/g for *Cucumeropsis mannii*. Some of the isolated microorganisms from the fermenting melon seeds include *Lactobacillus species*, *Bacillus species, Aerococcus viridans*, *Staphylococcus aureus*, *Micrococcus luteus*, *Aspergillus niger,* Penicillium species and *Fusarium eguseti*. *Cucumeropsis mannii* had the highest crude fibre and protein (12.7 and 38.5 mg/g) but lowest values for fat and ash while *Citrullus vulgaris* recorded the highest values of 35.3 and 3.4 mg/g There were no significant differences in values obtained for sodium, *Cucumeropsis mannii* had highest values for potassium and phosphorus (0.36 and 0.29 mg/kg). *Citrullus vulgaris* was outstanding in mineral content for magnesium with the highest value of 0.27 mg/kg and lowest for calcium (0.29 mg/kg)

**Corresponding author: Email: akinyelejuliet@yahoo.com; bamideleakinyele@gmail.com;*

compared to 0.30 and 0.34 for *Cucumeropsis mannii* and *Citrullus colocynthis* respectively. Anti-nutrients were highest in *Citrullus vulgaris* and lowest in *Cucumeropsis mannii*. Acidic pH of 5.78 was recorded in *Citrullus colocynthis* but increased to 8.91 and 8.69 in *Citrullus vulgaris* and *Cucumeropsis mannii* indicating that *Citrullus* c*olocynthis* may not be appropriate for ogiri production.
Conclusion: *Cucumeropsis mannii* compares favourably with traditionally used *Citrullus vulgaris* resulting in higher fibre, protein, mineral contents with lower values of anti-nutrients and therefore recommended as a good substitute for ogiri production.

Keywords: Fermentation; melon; condiment; ogiri; anti- nutrients.

1. INTRODUCTION

The quest of developing countries to make progress in meeting Millennium Development Goals (MDGs), especially in eradicating extreme poverty and hunger in particular, has called for aggressive research into some indigenous tree plants including *Pachia glabra* and *Afzelia Africana* [1]. *P. glabra* also known as Guinea peanut, French peanut or Lucky tree grows throughout the tropics and subtropics. Good nutrition is a basic human right and in order to have a healthy population that can promote development, the relation between food, nutrition and health should be reinforced. In recent times, attention has been focused on local seeds for possible development and use in the search for novel sources to complement the traditional ones. In developing countries, one of the possible ways of achieving this is through the exploitation of available local resources, in order to satisfy the needs of the increasing population [2].

Fermentation is one of the oldest ways of food processing. It is an operation carried out by using microorganisms and their enzymes to achieve desirable quality characteristics of food and food products [3]. During the process, microorganisms utilize biochemical constituents of the food, changing them from one form to another with the aid of microbial enzymes. This process enhances the palatability, increases protein value, vitamin content and mineral levels of such foods. It also improves food preservation, food safety, enhances flavour and acceptability. It increases variety in the diet, improves nutritional value, reduces anti-nutritional compounds and in some cases, it improves functional properties [4,5]. Although fermented food condiments have constituted significant proportion of the diet of many people, Nigerians have exhibited preference in terms of consumer tastes and preferences for such foods [4]. The prevailing population pressure in Nigeria, as in other developing nations of the world, has resulted in an increasing demand for wild under-exploited nutritious plant products with aesthetic and organoleptic appeal in the daily diet among which are, 'iru' from African locust bean (*Parkia biglobosa*), '*ogiri*' from castor bean (*Ricinus communis*), 'okpei' from mesquite seed (*Prosopis africana*) and ''ugba'' from African oil bean (*Pentaclethra macrophylla*) [6].

'Ogiri' generally refers to as an oily paste made from oil seeds in West Africa. They are also used as soup condiments with strong smell. It is a product of fermentation of melon seeds (*Citrullus vulgaris*) [4] consumed by the Ijebu and Ondo tribes in the forest zone of South Western Nigeria. *Ogiri egusi* is a food flavouring condiment prepared by traditional methods of uncontrolled solid state fermentation of melon seeds involving the use of chance fermentation.

In ogiri preparation, melon seeds are boiled until they are very soft and mashed. The mashed melon seeds are then wrapped tightly in banana leaves and left to ferment for five to seven days. Thereafter, the fermented mashed melon is placed in earthen well pot and covered with jute bags which provide low oxygen tension [7,8]. The fermenting mashed melon is still wrapped in leaves, placed on a wire mesh, smoked over charcoal heat at a distance for about two hour and pulverished before it can be used in cooking [7,4]. Ogiri can also be made from castor oil (*Ricinus communis*) seeds.

*Bacillus s*pecies and some members of the general Enterobacteriaceae are the microorganisms found consistently in the fermenting mash of most traditional condiments [6] with an increase in activity of proteinase as well as increase in amino acids during fermentation and a decrease in thiamine and niacin levels during the fermentation of castor oil beans and African melon seeds [9]. Although several works have been carried out on the fermentation of melon seeds, the resent work focuses on the fermentation of three different species of melon seeds and analysis of the antinutritional factors with the aim of identifying other related species that can be used for improved ogiri production thereby increasing its safety and nutritional quality for consumption.

2. MATERIALS AND METHODS

2.1 Collection of Samples

Melon seeds were purchased from 'Oba' market, Akure, Ondo State, Nigeria. The melon seeds were washed, de-hulled and rewashed. 600g each of the melon seeds were boiled for 4hrs, allowed to cool to about 30ºC, mashed and wrapped in banana leaves to ferment for five days.

Melon seed
↓
Dehulled
↓
Washing and boiling (4 hours)
↓
Mashing of boiled melon seed
↓
Packaging in banana leaves
↓
Fermentation at 28º± 2ºC
↓
Ogiri

Fig. 1. Flow chart for the fermentation of melon seed

2.2 Determination of Microbiological Properties of the Samples

Microbial isolation and identification was done using standard microbiological techniques [10]. Ten grams of each sample for microbiological evaluation was aseptically homogenized in 90 mL of 0.1% sterile peptone water, shaken thoroughly, and appropriate dilutions (up to 10) were prepared for microbiological studies. Total viable counts were made on Plate Count Agar (PCA, Oxoid, Hampshire, U.K.), while mold and yeast counts were made on acidified

Potato Dextrose Agar (PDA, Oxoid). PCA plates were incubated at 37º ± 2ºC for 24 h, while the plates for fungal and yeasts counts were incubated at 28º ± 2ºC for 72 h. Bacterial isolates were characterized based on cultural morphological and biochemical properties [11,12]

2.3 Determination of Proximate and Mineral Contents of the Samples

The proximate analysis was carried out using standard methods [13] while the mineral composition (iron, sodium, magnesium, potassium, copper, zinc, calcium, manganese.) of each sample was determined by wet ashing each of the samples, followed by flaming in Perkin-Elmer atomic absorption spectrophotometer while Phosphorus in the sample was determined colorimetrically using the Phosphovanado molybdate method [13].

2.4 Determination of Antinutrient (Phytin, Tannin and Oxalate) Contents

The method of Makkar [14] was employed for the determination of phytin and tannin while the oxalate content of the samples was estimated according to the procedure of Day and Underwood [15].

2.5 Determination of pH and Total Titratable Acidity (TTA)

A wrap of the fermenting seeds was taken at the start of fermentation and at 24 hours intervals for 5 days for the determination of pH and TTA. The sample was homogenized with distilled water and the pH determined using Jenway pH meter (model 3051) UK. Total titratable acidity was determined by titrating against 0.1M NaOH and the acidity of the sample solution was expressed in mg lactic acid per 100g sample.

2.6 Statistical Analysis

All data were analysed using SPSS and inferences made at 95% confidence limits using ANOVA. Duncan Multiple Range Test was used to separate means.

3. RESULTS AND DISCUSSION

Fig. 2 shows the microbial count for *Citrullus colocynthis* during the period of fermentation. Bacteria had the highest count than yeast and mould in the raw sample, while the values of mould count were higher than those of yeast counts in both unfermented and fermenting *C. colocynthis*. There were lower microbial counts on day 5 compared with day 1 to day 4 of fermentation.

Fig. 3 also showed highest bacteria count than both yeast and mould, while yeast counts were higher than that of mould. Bacteria count was high in both unfermented and fermenting *Citrullus vulgaris*. There was lower count of microorganisms at onset of fermentation when compared with day one to five. The yeast and mould counts were higher on day one of fermentation.

Also in Fig. 4, bacterial counts showed the highest values than yeast and mould counts. There was a gradual increase in yeast and mould counts during the fermentation period. Mould count was higher than that of yeast in the unfermented *Cucumeropsis mannii*.

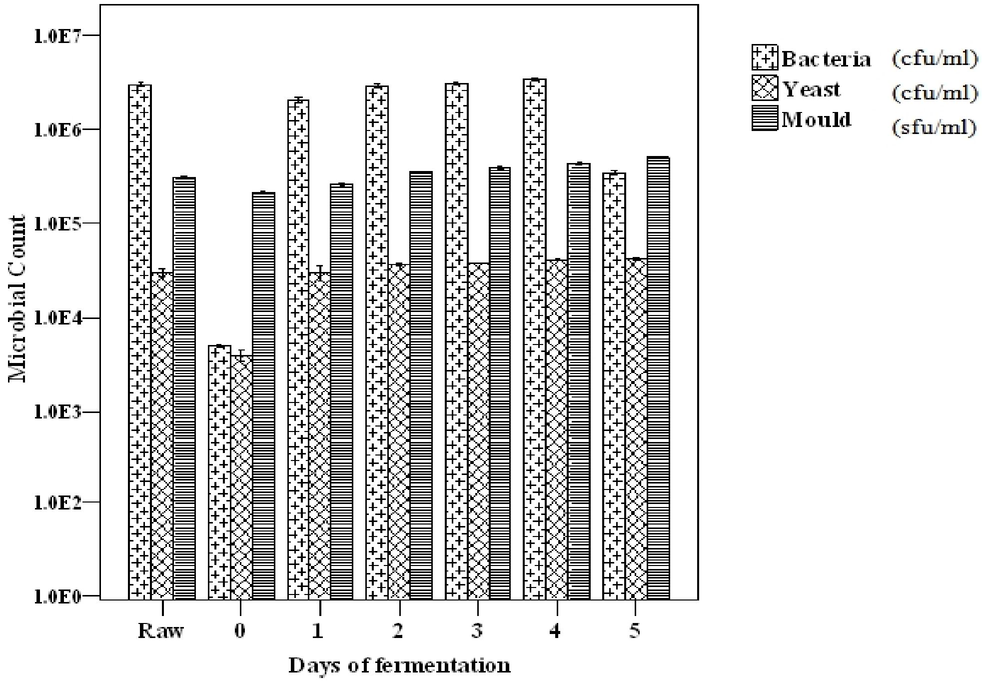

Fig. 2. Microbial count of unfermented and fermenting *Citrullus colocynthis*
**scientific notation 'E' – exponential/log into base 10*

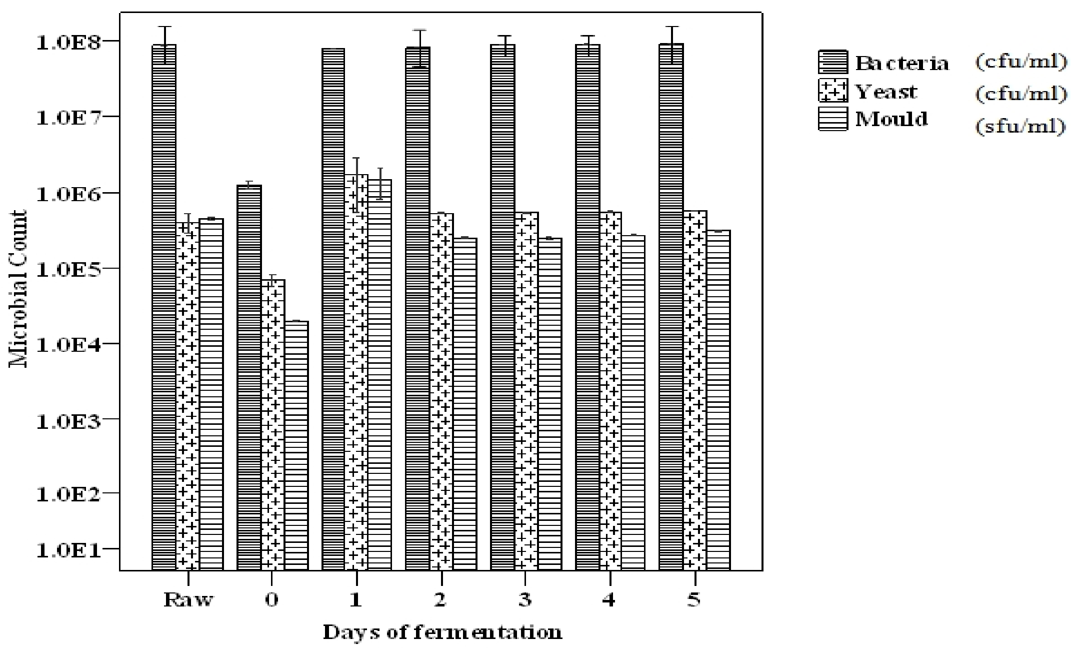

Fig. 3. Microbial count of unfermented and fermenting *Citrullus vulgaris*
**scientific notation 'E' – exponential/log into base 10*

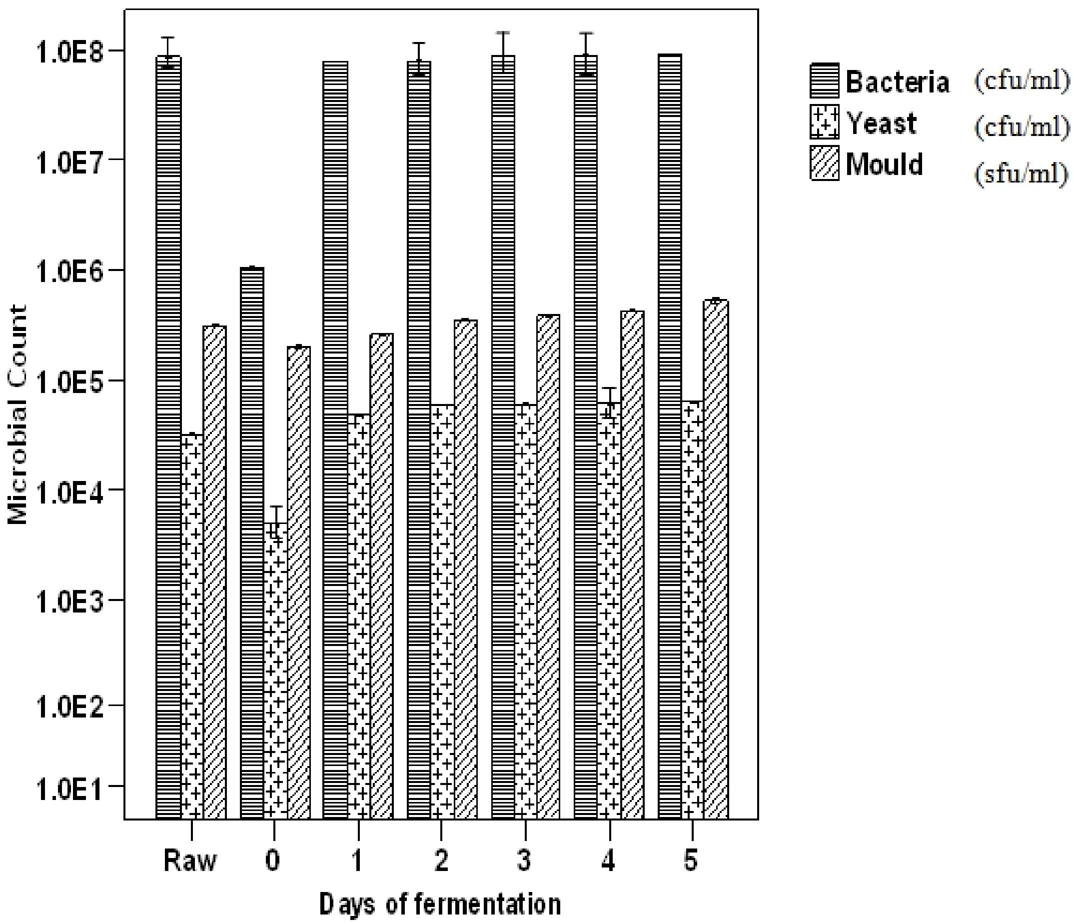

Fig. 4. Microbial count of unfermented and fermenting *Cucumeropsis mannii*
**scientific notation 'E' – exponential/log into base 10*

The bacteria isolates from the fermented and unfermented melon seeds are shown in Table 1. Bacteria isolates from *Cucumeropsis mannii* Naudin include *Lactobacillus brevis*, *Bacillus licheniforms*, *Leuconostoc cremoris*, *Lactobacillus fermenti*, *Lactobacillus casei*, *Micrococcus luteus*, *Aerococcus viridans*, *Aerococcus viridans*, *Bacillus cereus* and *Lactobabillus jenseni*, those from *Citrullus vulgaris* are *Leuconostoc cremonis*, *Bacillus sphaericus*, *Lactobacillus fermenti*, *Lactobacillus casei*, *Bacillus mycoide*, *Lactobacillus plantarum*, *Lactobacillus planetarium*, *M. luteus*, *Bacillus sphaericus*, *Leuconostoc cremonis*, *Lactobacillus plantarum* and *Staphylococcus aureus* while those isolated from *Citrullus colocynthis* include *Lactobacillus plantarum*, *Leuconostoc Lactobacillus jenseni*, *Lactobacillus fermenti*, *Bacillus mycoide*, *Lactobacillus jenseni*, *Bacillus cereus* and *Bacillus coagulans*. Some of the isolated *Lactobacillus* species may be strains of lactic acid bacteria (LAB) that are reported to have probiotic functions such as hipolipidemic and hepatoprotective properties [16]. There was a progressive increase in the microbial count of fermenting seeds according to [17]. They reported an increase from 30 cfu g^{-1} to $6.8x10^{11}$cfu g^{-1} during the fermentation of melon seeds while [18] recorded high aerobic count during the fermentation of African locust bean (*Parkia filicoides*) to produce 'dawadawa'. The high aerobic count might be due to high protein content of African yam been seeds with increase in temperature due to an increase in the bacterial population [19]. Similar findings were reported by [20]. Isolation of *Staphylococcus aureus* and *Bacillus* sp is in accordance with the findings of [21] during his study on the safety of traditionally prepared 'dawadawa'. *Bacillus* species may come from the air and the banana leaves used to wrap the melon seeds in which the mash was fermented. *Staphylococcus and Bacillus* species have been reported to be involved in the fermentation of vegetable proteins such as African locust beans ''dawadawa [8] 'ugba' from African oil beans [21], [9] 'owoh' from cotton seed [22] and okepehe from *Prosopis africana* seeds [23]. *Bacillus* species are known specifically for their ability to initiate fermentation of both nitrogenous and carbohydrate products [24,25].

Table 2 shows the mould isolated from unfermented and fermented melon seeds while Table 3 shows the yeast isolated. Molds isolated from *Cucumeropsis mannii include Penicillium spp.*, *Penicillium chrysogenum*, *Rhizhopus oligosporus*, *Aspergillus niger*, *Fusarium eguseti* and *Fusarium oxysporum* while *Penicillium chrysogenium* was isolated from *Citrullus colocynthis* Also mold isolated from *Citrullus vulgaris* were *Aspergillus fumigatus*, *Penicillium spp* and *Neurospora sp.* Isolated yeasts from *Cucumeropsis mannii* include *Zygosaccharomyces rouxii*, *Zygosaccharomyces mellis*, *Saccharomyces cerevisiae* and *Candida albicans var. Africans*. *Saccharomyces* sp. and *Aspergillus niger* were among the fungi isolated from fermented locust beans [26] reported the isolation of *Bacillus subtilis, Micrococcus varians*, *Enterobacter aerogenes* and *Corynebacterium* sp. from traditionally fermented oil bean seeds for ukpaka production confirming the ubiquitous nature of the organisms [27]. Apart from increasing the shelf life and reduction in anti nutritional factors, fermentation markedly improves the digestibility, nutritive value and flavor of the raw seeds. The increase in moisture content might be as a result of soaking and boiling which the seeds were previously subjected to before fermentation and the moist nature of the fermentation process [8] and the hydrolytic decomposition of the fermenting beans cotyledons had earlier been reported to contribute to the increased moisture content [28].

Table 4 shows the proximate composition of unfermented and fermenting *Citrullus vulgaris*. The crude fibre content had highest value on day five of fermentation. There were higher values of proximate compositions on day three and five of fermentation than the unfermented sample. Also crude protein was higher in unfermented sample than the fermented sample. Fat content was lower in the unfermented sample than the fermenting sample. The moisture content had highest value (7.27±0.13) on the fifth day of fermentation.

Table 5 shows the proximate composition of unfermented and fermenting *Citrullus colocynthis.* The crude fibre content had highest value on day five of fermentation. There were higher values on day three and five of fermentation than the unfermented sample. Also crude protein value was higher in unfermented sample (37.66±0.83) than the fermented sample. Fat content was lower in the unfermented sample than the fermenting sample. The moisture content had highest value (9.62±0.11) on the fifth day of fermentation. The ash content showed lowest value (2.24±0.20) on day three of the fermentation. Table 6 shows the proximate composition of unfermented and fermenting *C. mannii*.

Table 1. Bacteria isolated from fermented melon seeds

Sample	Raw	0hr	24hrs	48hrs	72hrs	96hrs	120hrs
Cucumeropsis mannii	*Lactobacillus brevis* *Bacillus. Licheniformis* *Micrococcus luteus* *Bacillus cereus*	*Bacillus licheniforms*	*Leuconostoc cremoris* *Bacillus licheniformis* *Aerococcus. Viridans* *Lactobabillus jenseni*	*Lactobacillus fermenti* *Lactobacillus casei* *Aerococcus viridans*	*Lactobacillus fermenti* *Lactobacillus casei* *Aerococcus viridans*	*Lactobacillus fermenti* *Lactobacillus casei*	*Lactobacillus. fermenti* *Lactobacillus casei*
Citrullus vulgaris	*Leuconostoc cremonis* *Bacillus mycoide* *Lactobacillus jenseni* *Bacillus sphaericus* *Lactobacillus plantarum*	*Bacillus sphaericus*	*Lactobacillus jeuseni* *Bacillus mycoide* *Lactobacillus planetarium* *Leuconostoc cremonis* *Staphylococcus aureus*	*Lactobacillus jenseni* *Bacillus mycoide* *Lactobacillus planetarium*	*Fermenti* *Lactobacillus plantarum*	*Lactobacillus fermenti* *Lactobacillus plantarum*	*Lactobacillus casei* *Lactobacillus fermenti* *M. luteus*
Citrullus colocynthis	*Lactobacillus plantarum* *Lactobacillus fermenti* *Lactobacillus cremoris*	*Leuconostoc cremoris*	*Leuconostoc cremoris* *Aerococcus viridans* *Bacillus mycoide* *Lactobacillus jenseni* *Lactobacillus fermenti* *Bacillus mycoide* *Lactobacillus jenseni* *Lactobacillus fermenti* *Bacillus cereus* *Bacillus coagulans*	*Leuconostoc cremoris* *Lactobacillus fermenti* *Lactobacillus jenseni*	*Leuconostoc cremoris* *Lactobacillus fermenti* *Lactobacillus jenseni*	*Leuconostoc cremoris* *Lactobacillus fermenti* *Lactobacillus jenseni*	*Leuconostoc cremoris* *Lactobacillus fermenti* *Lactobacillus jeuseni*

Table 2. Mould isolated from unfermented and fermented melon seeds

Sample	Raw	0hr	24hrs	48hrs	72hrs	96hrs	120hrs
Cucumeropsis mannii	*Penicillium spp. Rhizopus oligosporus Aspergillus niger Fusarium oxysporum*	*Penicillum chrysogenum*	*Penicillium. Chrysogenum Aspergillus niger Fusarium eguseti*	*Penicillium chrysogenum Aspergillus niger Fusarium eguseti*	*Penicillium chrysogenum Fusarium eguseti*	*Penicillium chrysogenum Fusarium eguseti*	*Penicillum chrysogenum Fusarium eguseti*
Citrullus colocynthis	*Penicillium chrysogenium*	*Penicillium chrysogenium*	*Penicillium chrysogenium*	*Penicillium chrysogenium*	*Penicillium chrysogenium*	*Penicillium chrysogenium*	*Penicillum chrysogenium*
Citrullus vulgaris	*Aspergillus fumigatus Penicillium spp*	*Aspergillus fumigates*	*Penicillium spp Neurospora spp*	*Penicillium spp*	*Penicillium spp*	*Penicillium spp*	*Penillicium spp*

Table 3. Yeast isolated from fermented melon seeds

Sample	Raw	0hr	24hrs	48hrs	72hrs	96hrs	120hrs
Cucumeropsis mannii	*Zygosaccharomyces rouxii*	*Zygosaccharomyces rouxii*	*Zygosaccharomyces rouxii*	*Saccharomyces cerevisiae*	*Zygosaccharomyces rouxii*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*
			Zygosaccharomyces mellis *Candida albicans var. Africans*	*Zygosaccharomyces rouxii* *Candida albicans var. Africans*	*Saccharomyces cerevisiae* *Candida albicans var. Africans*		
Citrullus colocynthis	*Saccharomyces rouxii*	NP	*Zygosaccharomyces mellis*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*
Citrullus vulgaris	*Saccharomyces cerevisiae*		*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*	*Saccharomyces cerevisiae*
	Candida albicans var.Africans	NP		*Candida albicans var. Africans*	*Candida albicans var. Africans*		

NP: Not present

The crude fibre content had highest value on day five of fermentation. There were higher values on day one of fermentation than the unfermented sample. Also crude protein value was higher in fermented sample (38.54±0.43) than the unfermented sample (36.81±0.02). Fat content was lowest on day one of fermentation. The moisture content had highest value (9.62±0.11) on the fifth day of fermentation. The ash content showed lowest value (2.24±0.20) on day three of the fermentation. Fat is important in diets because it promotes fat soluble vitamin absorption. It is a high energy nutrient and does not add to the bulk of the diet [29]. The crude protein content is comparable with that of soybeans, cowpeas, pigeon peas, pumpkin and gourd seeds ranging from 23.1- 33.0% [30]. The recommended daily allowance for protein for children ranges from 23.0-36.0g and for adults, 44-56g [31]. Maintenance of internal distensions for a normal peristaltic movement of the intestinal tract is the physiological role which crude fiber plays. It has been reported that a diet low in fiber is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer [23]. Many traditional methods of food preparation such as fermentation, cooking, and malting increase the nutritive quality of plant foods through reducing certain antinutrients such as phytic acid, polyphenols, and oxalic acid. Such processing methods are widely-used in societies where cereals and legumes form a major part of the diet.

Table 4. Proximate composition of unfermented and fermenting *Citrullus vulgaris*

	Days			
Parameter	**Unfermented**	**1**	**3**	**5**
Crude fibre	7.25±0.13	5.69±0.14	9.74± 0.81	11.59± 0.16
Crude protein	I37.76±0.86	29.12 ± 0.11	19.60±1.01	23.71±0.82
Fat content	26.85± 0.29	30.17±0.08	36.22±0.47	35.28±0.05
Moisture content	4.44±0.09	4.09±0.24	5.27± 0.34	7.27±0.13
Ash content	3.38±0.01	3.57±0.07	3.39±0.13	3.38±0.01

Table 5. Proximate composition of unfermented and fermenting *C. colocynthis*

	Days			
Parameter	**Unfermented**	**1**	**3**	**5**
Crude fibre	6.66±0.55	7.23±0.39	8.54±1.83	9.99±0.20
Crude protein	37.66±0.83	31.13±0.81	31.21±0.85	37.65±0.39
Fat content	32.64±0.46	34.00±0.34	36.20±0.42	33.92±0.23
Moisture content	4.55±0.05	5.19±0.13	6.44±0.18	9.62±0.11
Ash content	3.21±0.02	3.63±0.18	2.24±0.20	3.20±0.85

Table 6. Proximate composition of unfermented and fermenting *Cu. Mannii*

	Days			
Proximate	**Unfermented**	**1**	**3**	**5**
Crude fibre (%)	7.52±0.85	8.87±0.30	6.97±0.26	12.71±0.29
Crude protein (%)	36.81±0.02	28.91±0.01	34.87±0.15	38.54±0.43
Fat content (%)	29.15±0.13	23.28±0.03	38.75±0.02	31.43±0.07
Moisture content (%)	5.32±1.26	5.25±0.36	6.37±0.94	7.85±1.35
Ash content (%)	2.93±0.52	3.79±0.29	3.03±0.61	2.93±0.55

Fig. 5a shows the phytic acid contents of unfermented and fermented melon seeds. The phytic acid content was highest in *Citrullus vulgaris* and *Cucumeropsis mannii* on the third day of fermentation while it was slightly higher on the third day than the first day in *Citrullus colocynthis*. Phytin phosphorus (Fig. 5b) had highest value in all the three fermented samples on the third day of fermentation. It was higher in *C. vulgaris* on day 3 and 5 of fermentation than the unfermented sample. Also, there were higher values in *C. citrullus* during fermentation than the unfermented sample. *Cu. manni* had higher value in unfermented sample than day 1 and 5 of fermentation respectively.

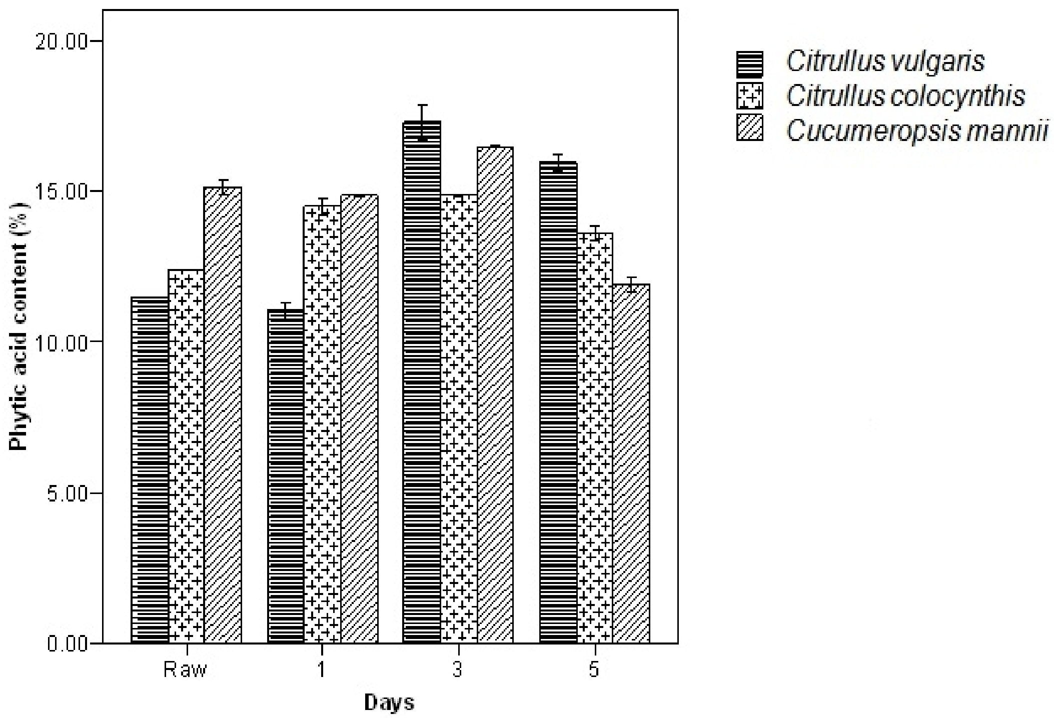

Fig. 5a. Phytic acid content of fermented melon seeds

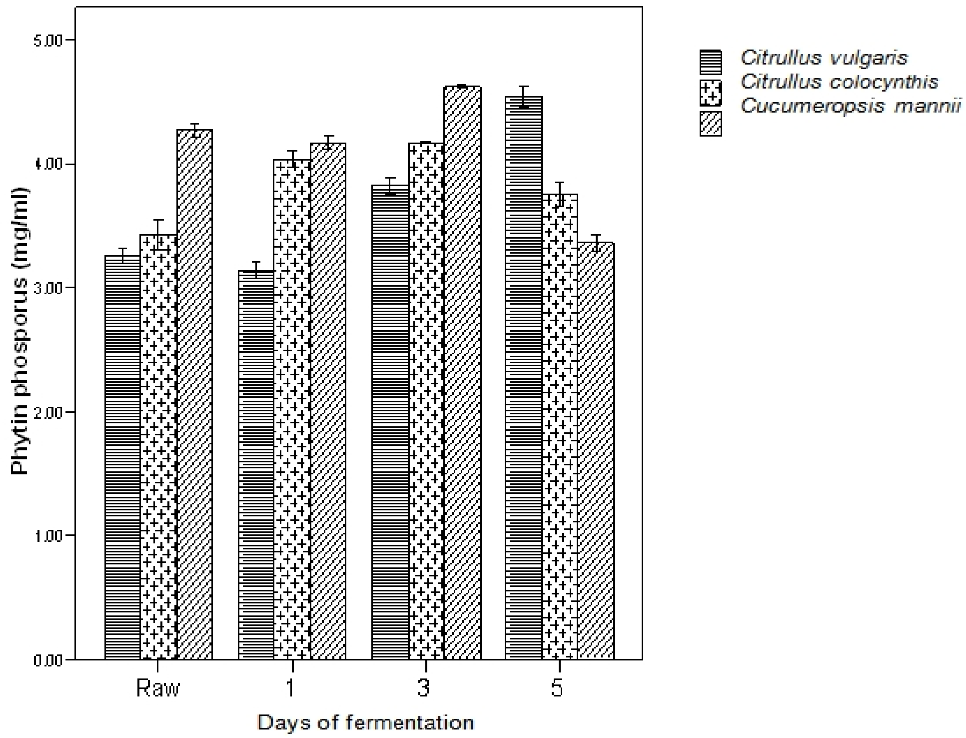

Fig. 5b. Phytin phosphorus of fermented melon seeds

Fig. 6 shows the oxalate contents of unfermented and fermented melon seeds. The oxalate contents of the unfermented melon seeds were higher than the fermented samples even at the fifth day of fermentation. Fig. 7 shows the tannin content of the unfermented and fermented melon seeds. Tannin showed highest value in *C. colocynthis* on the third day while it was highest on the fifth day in *Citrullus vulgaris*. Fig. 8 shows the titratable acidity (TTA) of the unfermented and fermented melon seeds. The TTA showed highest value in *C. colocynthis* on the fifth day while it was highest on the third day for *Citrullus vulgaris* and *Cucumeropsis mannii*.

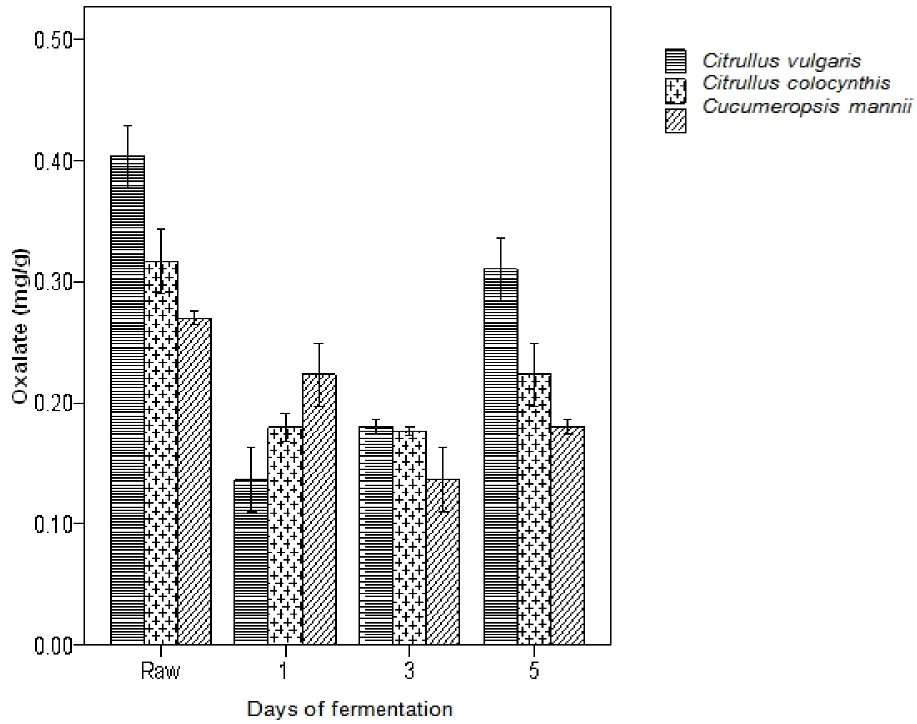

Fig. 6. Oxalate contents of fermented melon seeds

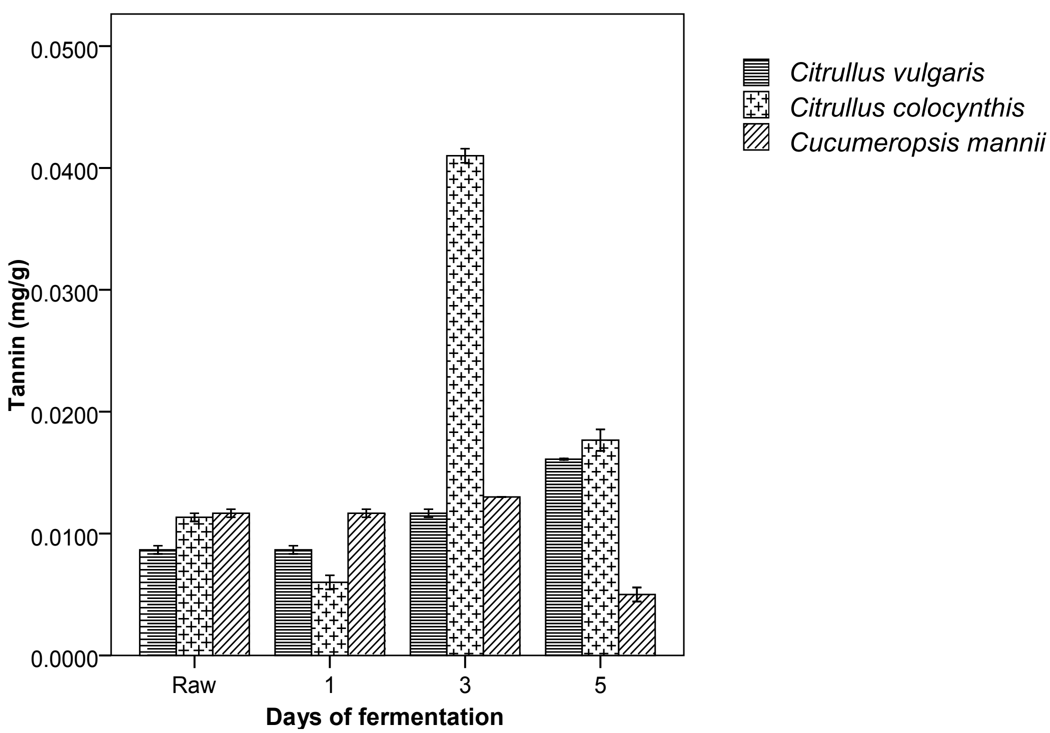

Fig. 7. Tannin content of fermented melon seeds

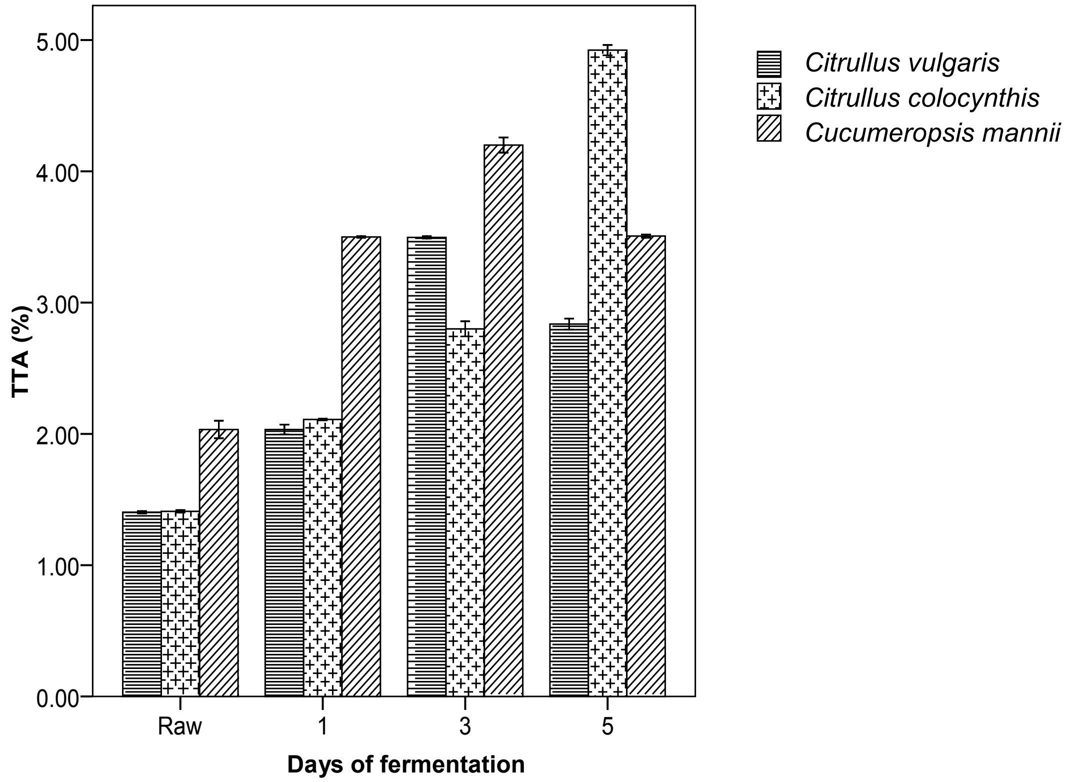

Fig. 8. Titratable Acidity (TTA) during fermentation of melon seeds

Table 7 shows the mineral composition for the unfermented and fermented melon seeds. There were variabilities in the mineral compositions of both unfermented and fermented melon seeds. The results on Table 8 show the pH values for both unfermented and fermented melon seeds. Fermented samples had higher values of 8.91±1.0 and 8.69±0.10 in *C. vulgaris* and *Cu. mannii* than their respective unfermented samples while fermented *C. colocynthis* had lower value of 3.67±0.01 when compared with the unfermented sample.

Antinutrients are natural or synthetic compounds that interfere with the absorption of nutrients and these compounds chelate metals such as iron and zinc reducing their absorption. They also inhibit digestive enzymes and precipitate proteins [32]. However, polyphenols such as tannins have anticancer properties and good for the health of consumers despite their antinutrient properties [33]. Legumes are particularly rich sources of natural toxicants including protease inhibitors, saponins, cyanogens, tannins, allergens, acetylenic furan and isoflavonoids [34].

Table 7. Mineral contents of the unfermented and fermented melon seeds

Minerals	*C. vulgaris* mg/kg	*C. colocynthis* mg/kg	*Cu. mannii* mg/kg
Ca*	0.397 ± 0.004^{c}	0.250 ± 0.043^{b}	0.241 ± 0.017^{c}
Ca	0.287 ± 0.33^{b}	0.341 ± 0.18^{d}	0.297 ± 0.42^{bc}
Mg*	0.145 ± 0.004^{b}	0.139 ± 0.041^{ab}	0.124 ± 0.016^{b}
Mg	0.274 ± 0.43^{b}	0.167 ± 0.12^{c}	0.163 ± 0.39^{bc}
K*	0.045 ± 0.005^{a}	0.244 ± 0.04^{b}	0.394 ± 0.010^{d}
K	0.290 ± 0.41^{b}	0.327 ± 0.10^{d}	0.364 ± 0.34^{c}
Na*	0.043 ± 0.004^{a}	0.36 ± 0.02^{a}	0.031 ± 0.002^{a}
Na	0.036 ± 0.24^{a}	0.034 ± 0.16^{a}	0.037 ± 0.26^{a}
P*	0.141 ± 0.004^{b}	0.176 ± 0.022^{ab}	0.08 ± 0.000^{ab}
P	0.113 ± 0.43^{a}	0.097 ± 0.14^{b}	0.293 ± 0.45^{b}

'' Unfermented sample*
Superscripts "a b, c and d" show significant difference. Values are mean ± SD (n=3)

Table 8. pH of both unfermented and fermented melon seed samples

pH	*C. vulgaris*	*C. colocynthis*	*Cu. Mannii*
Unfermented	7.09±0.01	5.78±0.20	7.96±1.02
Fermented	8.91±1.00	3.67±0.01	8.69±0.10

4. CONCLUSION, RECOMMENDATION AND PROSPECT FOR FURTHER RESEARCH

From the three species of melon seeds used, *Cucumeropsis manii* had the highest nutritional and mineral qualities as well as the lowest anti nutritional factors and can therefore compare favourably with the traditionally used *Citrullus vulgaris* for Ogiri production. This specie can also be recommended as the best substitute for large scale production of Ogiri. Further research into the interactions of microorganisms and banana leaves that is used in packaging during production is necessary for improved quality of fermented vegetable proteins for condiment production that will enhance further development and control of the fermentation process. Selection of starter cultures for large-scale industrial processes may require genetic modification so as to introduce a number of properties that may offer nutritional benefit in the form of increased protein production. There is need for further research into the probiotic potentials of some of the isolated microorganisms.

COMPETING INTEREST

Authors have declared that no competing interests exist.

REFERENCES

1. Ogunlade I, Ilugbiyin A, Osasona AI. A comparative study of proximate composition, antinutrient composition and functional properties of *Pachira glabra* and *Afzelia africana* seed flours. African Journal of Food Science. 2011;5:32–35.

2. Achu MB, Fokou E Tchiegang C, Fotso M, Tchouanguep FM. Nutritive value of some *cucurbitaceae* oilseeds from different regions in Cameroon. African Journal of Biotechnology. 2005;4:1329-1334.
3. Campbell-Platt G. Fermented Foods. In Encyclopedia of Food Microbiology ed. Robinson, R.K. Academic press. London, UK. 2004;736-739.
4. Achi OK. The Upgrading of traditional fermented foods through biotechnology. African Journal of Biotechnology. 2005;4:375-380.
5. Obute GC, Ndukwu BC, Florence C. Targeted mutagenesis in *Vigna unguiculata* (L.) Walp. and *Cucumeropsis mannii* (NAUD) in Nigeria. African Journal of Biotechnology. 2007;6:2467–247.
6. Enujiugha VN, Badejo AA. Cultural Alteration for the improvement of *Bacillus subtilis* in the fermentation of African oil bean seeds (*Pentaclethra macrophylla* Benth). Journal of Applied Tropical Agriculture. 2007;7:6-11.
7. Odunfa SA. African Fermented Foods, In: Woods, B.J.B (eds.) Microbiology of Foods, Vol 11, Amsterdam, Elsevier, Applied Science Publishers. 1985;155 –191.
8. Omafuvbe BO, Olumuyiwa SE, Bolanle AO, Steve RA. Chemical and biochemical changes in African locust bean (*Parkia biglobosa*) and melon (*Citrullus vulgaris*) seeds during fermentation of condiments. Pakistan Journal of Nutrition. 2004;3:140–145.
9. Odunfa SA. 'dawadawa'. In: Legume-based fermented foods (Reddy NR, Pierson MD, Salunkhe DK. eds.). CRC Press Inc., Florida. 1986;174–89.
10. Olutiola PO, Famurewa O, Sontag HG. (2nd Eds) An introduction to general microbiology, A practical Approach: Heldelberg Publishers; 2000.
11. Cheesbrough M. Biochemical tests to identify bacteria. In: Laboratory practice in tropical countries, Cheesbrough, M(Eds) Cambridge edn. 2002;36-70.
12. Barnnett JA, Payne RE, Yarrow D. Yeasts: Characteristics and Identification. 2001 3rd Eds.
13. Association of Official Analytical Chemists (AOAC). Official Methods of Analysis 18th edition, AOAC, Arlington, USA; 2006.
14. Makkar HPS. Gravimetric determination of Tannins and their correlations with Chemical and Protein Precipitation Method. Journal of Food and Agriculture. 1994;61:161-165.
15. Day RA, Underwood AL. Qualitative analysis 5th eds. Prentice-Hall Publications. 1986; 701.
16. Aderiye BI, Lalaye SA, Odeyemi AT. Hypolipodemic effect of *Lactobacillus* and *Streptococcus* species from some Nigeria Fermented Foods. Research Journal of Microbiology. 2007;538-544.
17. Barber LA, Achinewhu SC. Microbiology of 'Ogiri' production from melon seeds (*Citrullus vulgaris*). Nigerian Food Journal. 1992;10:123 – 35.
18. Jeff-Agboola YA, Oguntuase OS. Effect of *Bacillus sphaericus* on proximate composition of soybean (*Glycine max*) for the production of soyiru. Pakistan Journal of Nutrition. 2006;5:606-607.
19. Antai SP, Ibrahim MH. Microorganisms associated with African locust bean (*Parkia filicoidea* Welow). Fermentation fon 'dawadawa' production. Journal of Applied Bacteriology. 1986;61:145-148.
20. Villani F, Casaburi A, Pennacchia C, Filosa L, Russo F, Ercolini D. Study of the microbial ecology of the "Soppressata of Vallo di Diano", a traditional dry fermented sausage from Southern Italy, and in vitro and in situ selection of autochthonous starter cultures. Journal of Applied and Environmental Microbiology, 2007;73:5453-5463.
21. Odunfa SA. Microorganisms associated with fermentation of African locust bean during iru preparation. Journal of Plant Foods. 1981;3:245-250.

22. Obeta JAN, Ugwuanyi MAA. Microbiology of the production of okpeye, a condiment from seeds of *Prosopis africana* Taub. Journal of Tropical Science. 1996;36:206-210.
23. Sanni AI, Ayenor GS, Sakyi-Dawson E, Sefa-Dedeh S. Aerobic spore forming bacteria and chemical composition of some Nigerian fermented soup condiments. Journal of Plant Foods for Human Nutrition. 2006;55:111–8.
24. Sanni AI. Biochemical changes during the production of okpehe a Nigerian fermented soup condiment. Journal of Chemistry Microbiology Technology Lebensm. 1993;5:97-100.
25. Giami SY, Bekebain DA. Proximate composition and functional properties of raw and processed full-fat fluted pumpkin (*Telfairia occidentalis*) seed flour. Journal of Science Food Agriculture. 1992;59:321-325.
26. Achi OK. Quality attributes of fermented yam flour supplemented with processed soy flour. African Journal of Biotechnology. 1999;54:151-158.
27. Kolawole DO, Okonkwo BA. Microbiology of the traditional fermentation of oil bean (*Pentaclethra macrophylla* Benth) seeds for ukpaka, a Nigerian condiment. Nigerian Food Journal. 1985;2:149-152.
28. Reddy NR, Pierson MD. Reduction in antinutritional and toxic components in plant foods by fermentation. Journal of Food Research International.1999;281-290.
29. Omafuvbe BO, Abiose SH, Shonukan OO. Fermentation of soybean (Glycine max) for soy-dadawa production by starter cultures of Bacillus sp. Food Microbiology. 2002;19:456-651.
30. Olaofe O, Adeyemi FO, Adediran GO. Amino acid and Mineral Composition and functional properties of some oil seeds. Journal of Agricultural Food Chemistry. 1994;42:878-884.
31. National Research Council. Egusi. Lost Crops of Africa: Volume II: Vegetables. Lost Crops of Africa. National Academies Press.Washington, D.C. USA. 2006;155.
32. Gilani GS, Cockell KA, Sepehr E. Effects of antinutritional factors on protein digestibility and amino acid availability in foods. Journal of AOAC International. 2005;88(3):967–87.
33. Beecher GR. Overview of dietary flavonoids: nomenclature, occurrence and intake. Journal of Nutrition. 2003;133:3248 –3254.
34. Welch RM, Graham RD. Breeding for micronutrients in staple food crops from a human nutrition perspective. Journal of Experimental Botany. 2004;55:353–64.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=184&id=8&aid=895