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Nutritional composition, sensory evaluation and microbial activities of the traditional and enriched 'Akara Iwe' from Uya Oron in Akwa Ibom State, Nigeria West Africa

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ABSTRACT

This study was conducted to evaluate traditional 'akara iwe' as prepared and eaten by the people of Uya Oron in Oron Local Government Area of Akwa Ibom State, Nigeria, compared with enriched 'akara iwe' prepared in the Home Economics Laboratory, University of Uyo, Uyo, using the blend of ground fish powder and groundnut paste. These products were chemically analyzed for proximate composition, minerals, vitamins, antinutrients and sensory evaluation. Standard microbiological technique was used to assess the microbiological quality of the product. The enriched 'akara iwe' had the highest value for protein [19.75%], ash [5.25%] and beta carotene [350.96mg/100g] than traditional 'akara iwe', with protein [5.8%], ash [1.30%] and beta carotene [239.46%]. Microorganisms isolated from both 'akara iwe' were Penicillum sp [7.1%], A. niger [14.3%], yeast sp [21.5%], B. subtilis [11.9%], S. aureus [19.0%], S. epidermidis [11.9%] and Lactobacillus [14.3%]. Other food nutrients will encourage improvement for growth, development in infant, children and maintenance of body for adults. It will foster supply of micronutrients in the body. However, care should be taken during handling, preparation and storage of the 'akara iwe' to prevent microorganisms and their problems to health. 'Akara iwe' should be stored and consumed within three days.

Key words: Traditional 'akara iwe', Enriched 'akara iwe', Sensory evaluation and Microbial activities.

INTRODUCTION

"Akara Iwe" [Cassava fried cake] popularly known as 'akara uya oro" in Oron Local Government Area, Akwa Ibom State, Nigeria, is a ready-to-eat food made from cassava [*Manihot esculenta* crantz]. It is eaten as snack or with 'ogi' as an accompaniment for breakfast. School children and adults fondly use it as a 'favorite snack' to quench and satisfy hunger. It is very inexpensive, inviting, pepperish and tasty. The ingredients for the traditional 'akara iwe' consist of cassava mash mixed with red pepper, salt and red palm oil. However, cassava [*Manihot esculenta* crantz] is an important staple foodstuff and a source of calories for 200 – 300 million people in tropical areas. Protein content of fermented cassava is very low. [1] and [2] reported that cassava [*Manihot esculenta* crantz] is a major root crop in the tropics, and its starchy root is a significant source of calories for more than 500 million people worldwide. On the dry matter basis cassava roots contain 92.5% carbohydrate and 3.2% protein. Starch and sugar predominate, comprising about 90% [3].

However, Food and Agricultural Organization [FAO], World Health Organization [WHO] recommended that the total daily protein intake should be 67g, for the average Nigerian, of this 58% i.e. 39g, should be of animal origin.

But [1] revealed that only 20gms [i.e. 30%]. One of the world's problems is the lack of protein in the diet of many people. Furthermore, [18] and[4] observed that malnutrition, inform of protein, energy and micronutrient deficiencies, are still the major public health problems in Nigeria. That increase production and consumption of micronutrients rich foods would improve the micronutrients status of the Nigerian children. The 2000 – 2003 survey [5] revealed that 20% of the children, surveyed were iron deficient and 8% with depletion while 14.6% of the children had iodine deficiency and 29.5% of the children had deficiency of vitamin A.

Children need good nutritional start in life to ensure healthy growth and development [6]. Thus, good nutrition can be achieved by combination of variety of foods to include protein, fat, carbohydrate, vitamins and minerals. Plant protein can also be enriched by addition of animal proteins such as meat, fish, chicken and crayfish. They provide all essential amino acids when they are eaten in sufficient amounts [7].

Although traditional 'akara iwe' sold in Uya Oron is often limited to the ingredients of cassava mash, red pepper, salt and palm oil, it can be enriched for both infants, children and adults for the promotion of growth, development and maintenance using fish [which is abundantly available in different sizes and categories] in Oron and groundnuts found everywhere in Nigeria. There is paucity of information about the nutritional composition, microbial load/activities and sensory attributes of these blends.

MATERIALS AND METHODS

The necessary foodstuffs and all the materials required for the preparation of 'akara iwe' as well as traditional 'akara iwe' used as control for the study were purchased in Oron Local Government Area market.

Preparation of the Enriched 'Akara Iwe' with Ground Fish Powder and Groundnut Paste

Ingredient	Quantity
Grated cassava [from cassava stored for 24 hours]	6 cups
Ground 'bonga fish powder	½ cup
Chopped onions	1/3 cups
Salt [iodized salt]	3 teaspoons
Red palm oil [freshly obtained from palm Mill for mixing]	2 tablespoons
Groundnut paste	½ cup
Red palm oil [same as above but for shallow Frying]	1 lucozade bottle
Red pepper	2 teaspoon

Method of preparation

i) Cassava was peeled and washed under the running tap water
ii)They were grated
iii) Water was squeezed out from the cassava mash with muslin cloth to remove excess moisture.
iv) This was mixed with onions, red pepper, fish powder, groundnut paste, red palm oil (the one for mixing) and salt thoroughly mixed till well blended.
v)This was formed into small balls, flattened and placed in the tray.
vi) Red palm oil freshly obtained from the mill was heated till hot but not bleached.
vii) Four or five of the blend at a time were dropped in the hot oil [shallow frying till golden brown and crispy]
viii) They were removed and placed in the tray covered with tray cloth to, absorb excess fat/oil.
ix) They were milled into fine powder using manual grinder.
x) It was stored in air tight container.

Chemical Analysis

Ground 'akara iwe' was portioned into 4 parts. One part was used for proximate composition, mineral elements vitamins, antinutrients and microbial estimation. Proximate analysis of protein, crude fibre, ash, fat, moisture content, vitamins and minerals was carried out according to the method of A.O.A.C. [8]. The Microjeldahl method was used for the estimation of protein.

Lipid was determined by extracting a known weight sample with petroleum ether [B.pt. 40 – 60^{o}C] using Tecator Soxhlet apparatus. Ash was estimated by weighing 1g of each sample into a tarred porcelain crucible. It was incinerated at 60^{o}C for 6 hours in an ashing muffle furnace until ash was obtained. Moisture was determined using hot air oven method. Carbohydrate content was determined by difference. Energy calculation was based on Atwater factor [Protein x 4, Carbohydrate x 4, Fat x 9].

Mineral content was estimated using wet digestion with concentrated nitric and perchloric acids. The minerals iron [Fe], calcium [Ca], zinc, iodine, magnesium [mg] and copper were estimated by atomic absorption Spectrophotometer [Model 3030 Perkin Elmer, Norwak, USA]. Phosphorous[P] was determined calorimetrically with spectrophotometer using phospho-vanadomolydate method. Sodium was analyzed by flame photometry method. Pro-vitamin A [B-carotene] was analyzed by the method adopted from IVACG [1992].

Cyanide was estimated by the rapid enzymatic assay using linamarase extracted from cassava under laboratory condition using method of [9], Tannins were estimated by the method adopted by Akpan *et.al* [10]. Phytate was analysed by a photometric method adopted from the method of Latta and Eskin [1980]. All the determinations were in triplicates.

Sensory Evaluation

The sensory evaluation of the 'akara iwe' was conducted at the home Economics food laboratory. Twenty students from the University of Uyo were randomly selected to evaluate the likeness of 'akara iwe'. The nine hedonic scale where nine was the highest and one the lowest scores was employed. The rating scale for the degree of likeness were as follows: 9 - like extremely; 8 - like very much, 7 - like moderately; 6 - like slightly, 5 - neither like nor dislike, 4 - dislike slightly, 3 - dislike moderately; 2 - dislike very much, and 1 - dislike extremely. 'Akara Iwe' was presented to the 20 judges in white plastic plates.

Tap water was provided for the judges to rinse their mouth in between evaluation. The judges evaluated "akara iwe' for appearance colour, texture, taste, acceptability consistency and flavour.

Microbial Analysis

Sample A [traditional 'akara iwe' and B enriched 'akara iwe' were analysed] as thus: One gram each of the 'akara iwe' samples were weighed out, ground in a sterile mortar diluted with 9mls of sterile distilled normal saline under aseptic condition. 1ml from the diluents was used for serial dilution.

A series of tenfold serial dilution of the samples were carried out up to 1:1000. The bacterial load of the 'akara iwe' was determined by pour plate technique [12]. The autoclaved media were allowed to cool to about 45^{o}C and 1ml of aliquot from 10^{-3} dilution factor was aseptically transferred into petridishes in triplicate, about 20mls of molten plate count medium for total bacterial count, MacConkey agar for total coliform count and potatoe dextrose agar for mycological count were poured into the petri dishes containing the inoculum. It was swirled properly and allowed to set. The plates of the plate count agar and MacConkey agar were incubated at 37^{0}C while the potatoe dextrose agar plates were incubated at room temperature. The colonies of the emerging microorganisms after incubation were enumerated and recorded.

Pure culture of bacterial isolates were obtained by repeated sub-culturing and were examined for colonial morphology, microscopic appearance and biochemical characteristics using standard identification procedures by [13]. The test carried out includes Gram reaction, catalase, Urease, Coagulase, citrate utilization, oxidase, motility, carbohydrate fermentation, Voges – proskauer [VP] and Methyl Red [MR].

Statistical Analysis

Results were analysed using descriptive statistics by [14]. Significant level was accepted at P> 0.05.

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of traditional 'akara iwe' and 'enriched 'akara iwe'. Traditional 'akara iwe' had higher [P>0.05] lipid [37.00%], carbohydrate 55.43%] and caloric value [577.92%] than enriched 'akara iwe' [20.28%], [46.38%] and [447.04% respectively]. Enriched 'akara iwe' had higher [P>0.05] protein [19.75%] and ash [5.25%] than the traditional, 'akara iwe' [5.8% and 1.30% respectively].

Table 2 presents some minerals and vitamins. Enriched 'akara iwe' had higher [P > 0.05] B-Carotene [350.96mg], calcium [156. 20mg]. Phosphorus, [148.10mg], Potassium [139.11mg], Zinc [88.97mg], iodine [178.29mg], Iron [60.13mg] than traditional 'akara iwe' [239.46mg, 0.26mg, 0.24mg, 0.02mg, and 0.30mg, 0.01mg respectively].

Table 3 shows antinutrient contents of 'akara iwe'. Traditional 'akara iwe' had higher [P > 0.05] hydrocyanic acid [0.2mg] and phytate [0.05mg] than enriched 'akara iwe' [0.00mg respectively].

Table 1: Proximate Composition of Traditionally Prepared (Commercial Control) 'Akara' and Enriched 'Akara Iwe' (Dry Matter)

Parameter	Traditional 'akara iwe' (commercial control)	"akara iwe" enriched with fish powder
Moisture (%)	4.3 ± 0.02	3.05 ± 0.04
Ash (%)	1.30 ± 0.01	5.25 ± 0.02
Fibre (%)	0.47 ± 0.04	1.10 ± 0.01
Protein (%)	5.8 ± 0.01	19.75 ± 0.05
Lipid (%)	37.00 ± 0.25	20.28 ± 0.10
Carbohydrate (%)	55.43 ± 1.0	46.38 ± 0.20
Caloric Value (Kcal)	577.92 ± 1.22	447.04 ± 1.20

Mean ± SD of three determinations

Table 2: Vitamins and Mineral Elements of Enriched and Traditional 'Akara Iwe'

Nutrients/ Parameters	A Traditional 'akara iwe'	B Enriched 'akara iwe' with fish
Fe (mg/100g)	0.23 ± 0.01	60.13 ± 1.00
Ca (mg/100g)	0.26 ± 0.01	156.20 ± 1.20
P (mg/100g)	0.24 ± 0.10	148.10 ± 1.00
K (mg/100g)	0.02 ± 0.00	139.11 ± 1.23
Zn (mg/100g)	0.30 ± 0.05	88.97 ± 1.02
Iodine (mg/100g)	0.01 ± 0.00	178.29 ± 1.01
Na (mg/100g)	101.25 ± 1.10	110.22 ± 1.05
Bi (mg/100g)	0.10 ± 0.02	1.05 ± 0.05
B2 (mg/100g)	0.9 ± 0.01	2.10 ± 0.04
Beta carotene (mg/100g)	239.46 ± 1.23	350.96 ± 1.22

Mean ± SD of three determinations.

Table 3: Anti-nutrients Contents of 'Akara Iwe'

Parameters	Traditional 'akara iwe'	Enriched 'akara iwe'
Cyanide (mg)	0.2 ± 0.00	0.00 ± 0.00
Phytates (mg)	0.05 ± 0.00	0.00 ± 0.00
Tannins (mg)	0.00 ± 0.00	0.00 ± 0.00
Oxalate (mg)	1.00 ± 0.02	0.02 ± 0.00

Mean ± SD of three determinations

Table 4: Sensory Evaluation of 'Akara Iwe'

Attributes	Traditional 'akara iwe' (Control picked from the market)	B 'Akara iwe' enriched with fish and groundnut paste
Taste	6.35 ± 0.2	9.20 ± 0.13
Texture	6.25 ± 0.4	7.55 ± 0.2
Colour	8.85 ± 0.3	6.16 ± 0.4
Flavour	6.65 ± 0.2	9.60 ± 0.2
Consistency	6.71 ± 0.2	7.86 ± 0.2
General Acceptability	7.82 ± 0.4	9.84 ± 0.2

Mean ± SD of 3 determinations

Table 5: Total Heterotrophic Bacteria Encountered in "akara iwe"

	Code A (Traditional 'Akara Iwe')		Code B (Enriched 'Akara Iwe')	
Days	THBC ± mean SD (cfu/g)	TCC ± mean SD (cfu/g)	THBC ± mean SD (cfu/g)	TCC ± mean SD (cfu/g)
1	$6.0 \pm 0.08 \times 10^4$	NIL	NIL	NIL
2	$1.0 \pm 0.20 \times 10^5$	NIL	NIL	NIL
3	$7.6 \pm 0.03 \times 10^5$	NIL	$0.6 \pm 0.02 \times 10^4$	NIL
4	$9.5 \pm 0.05 \times 10^5$	NIL	$1.2 \pm 0.09 \times 10^5$	NIL
5	$1.19 \pm 0.01 \times 10^6$	NIL	$5.4 \pm 0.09 \times 10^5$	NIL

A= Untreated Sample of 'akara iwe' – traditional 'akara iwe' as bought from the market:
B= Treated sample of 'akara iwe' prepared in Laboratory.
THBC= Total Heterotophic Bacteria Counts
TCC= Total Coliform Counts

Table 6: Total Heterotrophic Fungi Count (THFC)

Days	Traditional 'akara iwe' THFC ± SD	Enriched 'akara iwe' THFC± SD
1	9.0 ± 0. 02 x 10^4	7.0 ± 0.03 x 10^4
2	2.1 ± 0.04 x 10^5	1.5 ± 0.05 x 10^5
3	3.5 ± 0.09 x 10^5	2.7 ± 0.02 x 10^5
4	4.7 ± 0.04 x 10^5	4.4 ± 0.09 x 10^5
5	6.2 ± 0.10 x 10^5	5.6 ± 0.10 x 10^5

Table 7: Fungi isolated in 'akara iwe'

Days	A Traditional 'akara iwe'	B Enriched 'akara iwe'
1.	*Penicillium* sp	Yeast sp
2.	Yeast sp, *A. niger*	Yeast sp
3.	*Penicillum* sp, Yeast, *A. niger*	Yeast sp
4.	Yeast sp, *A. niger*	Yeast sp, *A. niger*
5.	*A. niger*, yeast, *Penicillium* sp	Yeast sp, *A. niger*

Table 8: Bacterial Isolated in 'Akara Iwe' Per Day

Days	A Traditional 'akara iwe'	B Enriched 'akara iwe'
1.	*Staph. aureus, Bacillus Subtils epidermidis*	Nil
2.	*Staph. aureus Bacillus Subtils epidermidis*	Nil
3.	*Staph. aureus, Bacillus Subtilis*	*Staph. aureus*, lactobacillus
4.	*Staph. aureus, Bacilus Subtilis, S.epidermidis*	*Staph. aureus*, lactobacillus
5.	*Staph. aureus, Bacilus Subtilis, S.epidermidis*	*Staph. aureus*, lactobacillus

Table 9: Percentage Occurrence of Microorganisms Isolated

Microorganisms	No. of Occurrence	% of Occurrence
Penicillium sp	3	7.1
A. niger	6	14.3
Yeast sp	9	21.5
B. subtilis	5	11.9
S. aureus	8	19.0
S. epidermis	5	11.9
Lactobacillus	6	14.3
Total	**42**	**100**

Table 4 presents sensory evaluation of 'akara iwe'. Traditional 'akara iwe' had higher [P > 0.05] colour [8.85] than enriched 'akara iwe' [6.16]. The enriched 'akara iwe' had higher [P > 0.05] general acceptability [9.84] Flavour [9.60], taste [9.20] than traditional 'akara iwe' [7.82, 6.65 and 6.35 respectively].

Table 5 shows total heterotrophic bacteria encountered in 'akara iwe'. The results of the analysis of traditional 'akara iwe' [Sample A] and enriched product [sample B] reveals no coliform growth in all samples and no total heterotrophic bacterial count [THBC] on the first and second day in sample enriched 'akara iwe'. The THBC of Sample A ranged from 6.0 ± 0.20x10^4 the first day to 1.19 ± 0.01 x 10^6 on the fifth day while B had 0.6 ± 0.12 x 10^4 on the third day, the growth increases to 5.4 ± 0.50 x 10^5 cfu/g on the fifth day.

The analysis in table 6 also reveals the Total Heterotrophic Fungi Counts [THFC] in sample A ranging from 9.0 ± 0.02 x 10^4 cfu/g on the first day to 6.2 ± 0.10 x 10^5 cfu/g on the fifth day while the THFC in sample B ranged from 0.7 ± 0.03 x 10^4 the first day to 5.6 ± 0.10x10^5 cfu/g on the fifth day. In Table 7, the mycological species were predominantly yeast, followed by *Aspergillus niger* and *Penicillium* spp. Only yeast spp. were isolated from sample B while *Penicillium* sp. and *A. niger* and Yeast sp were isolated from sample A. The predominant bacterial isolate in Table 8 was *S. aureus* followed by *Lactobacillus*, *B. subtilis* and *S. epidermidis*. Table 9 shows the percentage occurrence of the isolates and the higest occurring organism is yeast sp followed by S. aureus.

The high value of iodine suggests that fish and iodized salt could be an essential component of the 'akara iwe' to supply iodine to the body [21 and22]. One hundred grams of salt water fish provides iodine about 150µg from 350µg between twice and thrice times RDA. Also, a half teaspoon [2g] of iodide fortified salt supplies the adult RDA for iodide with RDA being 150µg/day for adult and the minimum to prevent goiter is 50ug/day [19 and 24].

Protein value was high due to the present of groundnut and fish. Nuts are a well balanced nutritious food, providing protein, fibre, vitamins and minerals, unsaturated fatty acids and phytochemicals. Fish contains 15% to 20% proteins, an amount similar to meat and nuts 25.8g/100g. Fish protein is highly digestible and a good source of all the essential amino acids. Protein is needed for growth, maintenance and regulation of body processes [17] Research reveals that total weekly intake: 8 ounces [240g] runs lower risk of heart attack than people who rarely eat fish[19], edible sea fish contains approximately 300 to 3000ng/kg of fresh water fish. The daily iodine requirement of iodine is reported to be 100g-150ng[22].

The enriched 'akara iwe' is greater than the recommended daily allowance 13.5g body for 1 - 2 year and 15.5g / day for 2 – 3 years [15]. Fat value of the enriched 'akara iwe' is lower than the RDA for infants 0 to 6 months and 7 to 12 months but adequate for the absorption of vitamins A, E, K in the body. Fats supply concentrated energy, fish fat [cod liver] is in unsaturated fatty acids as well as fat-soluble vitamins A and D [20 and 22]. Furthermore, the fat content of the enriched 'akara iwe' with fish and nut has met the Food and Nutrition Board requirement that consumption of fish at least twice a week is one step toward meeting requirement for essential fatty acids. (23). Fat is important for providing energy for the body, storing energy for later use, insulating and protecting the body, and transporting fat soluble vitamins (19).

The high energy value of the 'akara' results from the fat contents in traditional and enriched 'akara iwe'. 100g to 300g was enough to support both infants, children and adults energy requirements. The anti-nutrients were low enough not to interfere with the absorption of nutrients in the body. Oxalate content was below toxic level [1]. Table 9 shows the percentage occurrence of isolates. The least was *Penicillium* sp 7.1% while the highest was *S. aureus* 21% followed by Yeast spp 21.5%, *Lactobacillus* 14.3%, *B. subtilis* and *S. epidermidis* 11.9%.

The higher values of protein, ash, iodine, β-carotene, Ca, P and iron found in 'akara iwe' enriched with fish and nut-groundnut than the traditional 'akara iwe' show better source of nutrient. The high β – carotene especially in the rich 'akara iwe' with freshly prepared red palm oil suggest a good source of Pro-Vitamin A. Also according to Pamplona (2006) fish contains liposoluble vitamin A and D, pro-vitamin A and the Vitamin A retinal are necessary for good vision, healthy epithelial cells, immunity against infections, cell growth and differentiation and cancer prevention and treatment. The high level of ash indicates that enriched 'akara iwe' is capable of supplying minerals to the body.

The iodine content of fish ranges between 28 and 55ng/100g [24]. However, this is heme iron, which is absorbed better than that found in vegetable foods which are non-heme. Pistachios and peanuts (groundnuts) provide the most iron. Iron is important for its antioxidant effect, production of red blood corpuscles, oxygen transportation and the functioning of many enzymes (6). Iron also functions as a cofactor for some enzymes, including those involved in the synthesis of collagen and of various neurotransmitters, (e.g. dopamine, epinephrine, norepinepthrine and serotonin). The high level of vitamin A will favour the utilization of iron in the body as deficiency of vitamin A may impair the body's ability to release iron from the body store [1&2].

The high levels of calcium and phosphorous can be attributed to the enrichment of 'akara iwe' with fish. Fish like meat is very rich in phosphorous than calcium and there is no risk of deficiency with a balanced diet. Phosphorous is required for bone and tooth strength, serves as part of various metabolic compounds, functions as major iron of intracellular fluid, acid, acid-base balance [15].

Phytic acid content of the 'akara iwe' was traced and not capable of affecting availability of minerals in body. In confirmation with [16] ingestion of 2.5g or more of the phytic per day may cause reduction in bioavailability of calcium, iron and zinc. The cyanide content in the commercial akara iwe (traditional) was higher than enriched cassava due to the fermentation undertaken by the later 24 hours. Fermentation of cassava achieves the positive role of modifying the functional properties of starch and this conferred preservation, in the final product (16). Also grating results in 90% reduction in cassava glucosides

The possible entry of the pathogens isolated may probably be from the initial raw materials, processing equipment and food handlers themselves. The source and spread of microorganism in an indoor environment are important issues and human related organisms or the body normal flora, also found in clothing are spread through shedding during human activities (17). *Bacillus* sp are mostly saprophytes widely distributed in nature and the broad range of physiologic characteristics exhibited within the genus is reflected in a range of facultative variants that are capable of survival in spore form or even at growth at environmental extremes (17).

The storage condition and exposure of both products to absorb moisture from the air and air-borne microorganisms especially during sales encourage growth of microorganisms. Both pathogenic and non pathogenic organisms were

isolated, though majority of the isolates were non pathogenic. The amount of moisture in a food affects the activities of microorganisms. The colony counts and number of isolates were higher in traditional prepared 'akara iwe' than 'akara iwe' prepared in Home Economics Laboratory, this might be as a result of poor preparation of traditional 'akara iwe'. Communities using 'akara iwe' as food supplement or snack should be educated on hygienic preparation and handling as this threatens the health of individuals because pathogenic organisms involved.

CONCLUSION

This study has shown that substitution of the cassava mash with up to 10% fish powder and 10 percent groundnut paste can give a mash that will produce akara iwe enhance nutritional quality in terms of protein, vitamins, minerals and better carotene content. Such akara iwe can have higher acceptability than 100% cassava mash (Traditional akara iwe). This is suitable for growth, development in infant and maintenance for adults, but care should be taken not to store beyond three days to prevent microbial activities that pose health problems and danger for consumers. The public should be educated on sanitary aspect during preparation and hawking.

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