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POTENTIALS OF *TAMARINDUS INDICA (Linn)* IN JAM PRODUCTION

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ABSTRACT
This study was conducted to investigate the potential of tamarind fruits in jam production with a view to improving utilization efficiency of the fruits thereby adding value to the tree and encouraging its cultivation and sustainable management. The fruits for the study were collected from Bishop Ajayi Crowther University, in Atiba Local Government Area of Oyo town, Oyo State and Taironi Local Government Area of Kano State, Nigeria. The jam was prepared using variable proportions of pulp and sugar. Chemical and microbial analyses were carried out on the jam. Heavy metal contents were determined and sensory evaluation was carried out. Physical and chemical properties of jams produced from the fruits of the two locations were compared. Data generated was analyzed using students t-test. There is no significant difference ($p \leq 0.05$) in the moisture contents of the jams produced from the fruits from both locations. Some essential elements including Zn (0.74mg), Mg (0.68mg), Cd (0.26mg), Mn (0.94mg), Pb (0.55mg), Fe (0.29mg), Cr (0.67mg), and Cu (0.17mg) were contained in the jam. The levels of heavy metals found in the jam are significantly lower than the UN/WHO allowable standard for human consumption while some of the other metals are actually of high nutritional values. There are indications that the jam could keep well at room temperature. Oyo State sample is higher in mineral element than that of Kano State. The ascorbic acid content is low in both Kano and Oyo samples. Pulp and sugar were rated most acceptable by a panel of judges on a nine point hedonic scale. Tamarind possesses great potentials for jam making and is safe for human consumption and well accepted by consumers. Further development of the jam to an industrial status was recommended.

Key words: Non-Timber forest Products, Value addition, *Tamarindus indica (Linn)*, Jam

INTRODUCTION
Historically, mankind has exploited and utilized non–timber forest products (NTFPs) for his livelihoods. Forest produce contribute significantly to economic development, industrial growth and general welfare of the world population (Cavendish 2001). Natural products have been gathered for foods, medicines, fibers, resins, bio-chemicals, oil as well as animals. The tropical forests of Nigeria are rich in plant species (biodiversity) with high potentials to meet the fundamental needs of man which are basically food, services and raw materials (Jimoh,2005).

NTFPs as described by Wickens (1991) are biological materials other than industrial round wood, wood chips etc that may be extracted from natural ecosystem which have social, religious and cultural significance and may be utilized within the household. Forest resources are vital to continuous human existence because most of them are capable of providing nutritional values and are traditionally used as supplements to staple diets (FAO, 1990). NTFPs provide food, medicines, fibers, and cash income for rural households (Okafor *et al.,* 1994), but, it is worrisome that NTFPs are frequently under- valued and are often wasted during harvesting, processing and storage. NTFPs are not considered in the financial and economic analysis of forest projects despite the fact that they are equally if not more important in rural household's welfare than the timber component of the forest (Egunjobi, 1996). For instance, the Central Bank of Nigeria(CBN) (1995) reported only oil palm and Shea oil as Nigeria's major food and industrial crops with prospect up to 1990.Consequently, government has paid less attention to the contribution of NTFPs to the national economy. The neglect has contributed to the low pricing of the NTFPs and abuse of the resources by exploiters which often results in wastes. However, recently there has been a change of attitude with the realization that timber is not the only valuable resource of the forests, but that NTFPs are equally important, if not more important than the Wood product especially to the rural economy of a developing country like Nigeria (Osemeobo,2003).

Tamarind (*Tamarindus indica L.)* is a tree-type of plant which belongs to the family *Fabaceae* and subfamily Caesalpinioidae. It is indigenous to tropical Africa but has become naturalized in North and South America, from Florida to Brazil, and is also cultivated in subtropical China, India, Pakistan, Indochina, Philippines, Java and Spain (Gunasena and Hughes, 2000). Initially, the fruit shows a reddish-brown color that turns black or black brown, becoming more aromatic and sour on ripening (Plate 1). The fruit pulp is used for seasoning, as a food component and in juices. Its fruit is regarded as a digestive, carminative, laxative, expectorant and blood tonic (Komutarin *et al.,* 2004). In Nigeria, particularly in northern parts inhabited by the *Hausa -Fulani* tribes where it is known as *tsamiya*, the pulp is used as a sweetener in sorghum and millet porridge. Other parts of the plant are used as antioxidant (Tsuda *et al.,* 1994), anti hepatoxic (Joyeux *et al.,* 1995), anti-inflammatory, anti mutagenic (Ramos *et al* 2003) and anti diabetic (Maiti *et al.,* 2004). Tamarind is a versatile fruit, which can be used for many purposes. Tamarind pulp has been used for many medicinal purposes and continues to be used by many people in Africa, Asia and America (Gunasena and Hughes, 2000). The pulp is believed to improve appetite and is used as a gargle for sore throats, dressing of wounds and is said to aid the restoration of sensation in cases of paralysis. The unique sweet/sour flavor of the pulp makes it popular in domestic cooking and flavorings. Kokwaro (1976) also reported that leaves and bark of *Tamarindus indica* have medicinal properties. The species is thus an important one in most landscapes of the dry lands in Nigeria.

Recently, there has been an increased awareness on the contribution of NTFPs to socio-economic well being and food security particularly in the rural areas (Okafor 1991, Jimoh 2005). However, most of these efforts have concentrated on the crude

method of utilization with little or no value addition. It is pertinent at this moment to move beyond mere recognition of traditional utilization and to research into the development potentials of these species for various uses such as medicine, food, flavours, spices, sweeteners and cosmetics (Nyandoi, 2004). Furthermore, most of the advances in the development potentials of NTFPs particularly nutritional studies focus on the medicinal aspect of the plants and ignore all other products derivable from NTFPs. The extraction, processing and utilization of many NTFPs in Nigeria are still crude and inefficient due to poor handling and lack of storage facilities. This has affected the pricing of many of these products in many cases, they are sold at ridiculous prices and this encourages wastage and deems the prospect of sustainability.

The study aims at value enhancement in *T.indica* in Nigeria with a view to stimulating interest in its cultivation and sustainable management. Therefore, the study objectives were: to investigate the potentials of *T. indica* as a raw material for jam production; identify the nutritional and anti-nutritional elements such as heavy metals present in the pulp; compare the level of heavy metals in the pulp with the World Health Organization (WHO) standard and investigate the acceptability of the jam produced.

MATERIALS AND METHODS

Fruit Sources

Ripe fruits of *T.indica* were collected from the premises of Bishop *Ajayi* Crowther University, *Atiba* Local Government Area, Oyo State and *Taironi* Local Government Area of Kano State Nigeria. These two locations are a fair representation of the ecological distribution of the species in Nigeria(Figure 1).

Atiba Local government Area is located on latitude 9^0 30'N and longitude 6 º 45' E (figure 1) with topography lying between 300m and 600m. It exhibits a typical climate of high temperatures, and high relative humidity. Annual rainfall has a wide range between 1200mm and 1800mm and there are two rainfall peaks coming in June-July and September – October. Kano State is located between latitudes 12^0 40' and 10^0 30' and longitude 7^0 40' and 9^0 30'. The average annual rainfall is about 1000mm in the southern part of the state, 800mm around metropolitan Kano and about 600mm in the north-east. The rainy season usually covers the period of May to October followed by dry season which usually begins in November and ends in May.

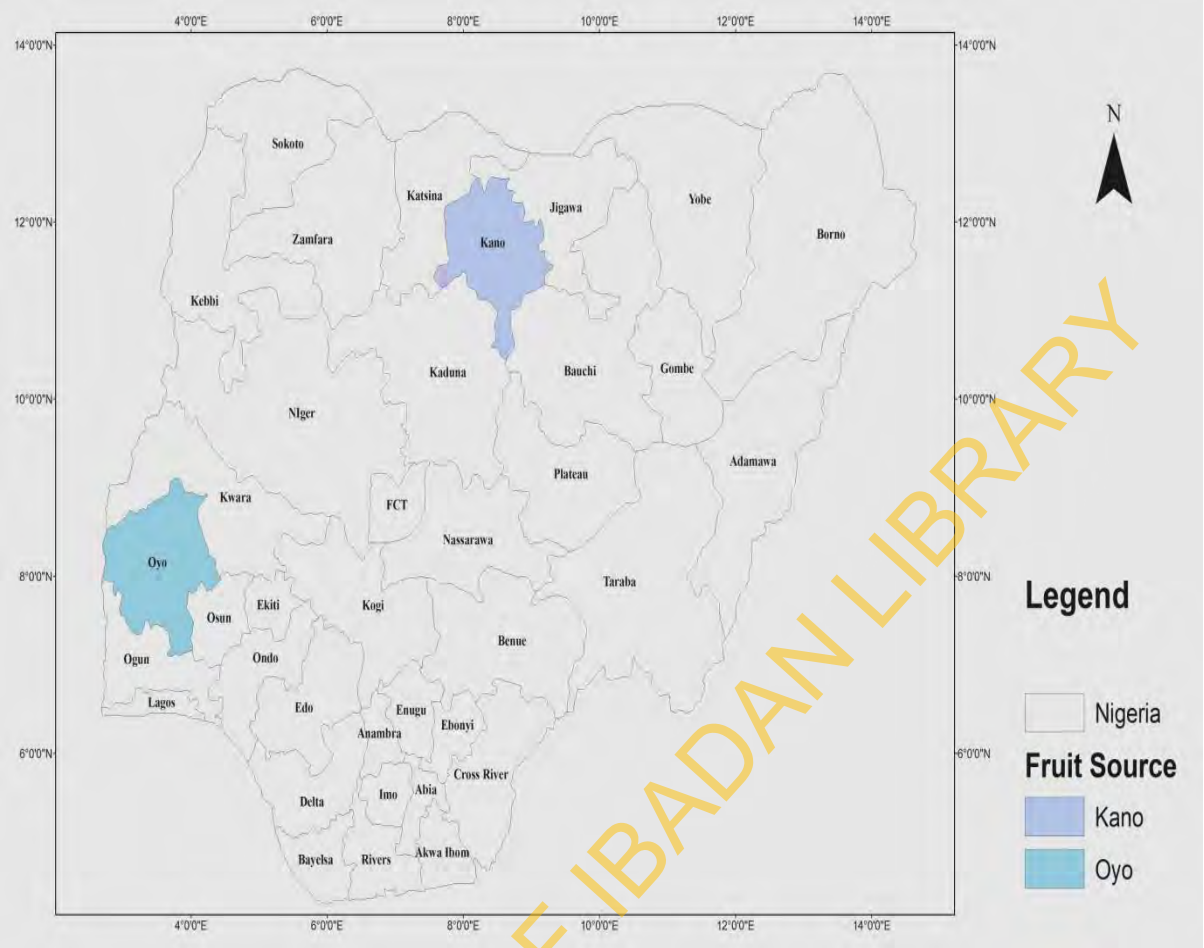


Fig. 1: Map of Nigeria Showing the Fruit Sources

Fruit Collection and processing

Fresh and ripe fruits of *Tamarindus indica L*. were collected from at least ten mother trees in each of the study sites. The fruits from each state were mixed and washed thoroughly in distilled water to remove extraneous materials. The fruits were then air-dried. Bruised and spoilt fruits were discarded. A randomly selected clean sample of the fruit pulp was extracted from the fruits by soaking in clean water for 30mins. The pulp was separated from the seeds by sieving.

The jam preparation process

The jam was produced by using the open kettle process (Moyls, *et al.,* 1962). The pulp was then blended with 20% water weight to weight by using a ken-wood blender. The finely blended pulp was boiled for 30 minutes after which most of the water had evaporated. Sugar was added gradually as boiling continued until the total soluble solid reached 68%. The jam produced was then cooled at 80^0C before pouring into bottles. The production process was carried out separately for the pulp from the two sources. Fig 2 depicts the flow diagram for *Tamarindus indica L.* jam production process. Plate 1 shows fruits of *Tamarindus indica L.*

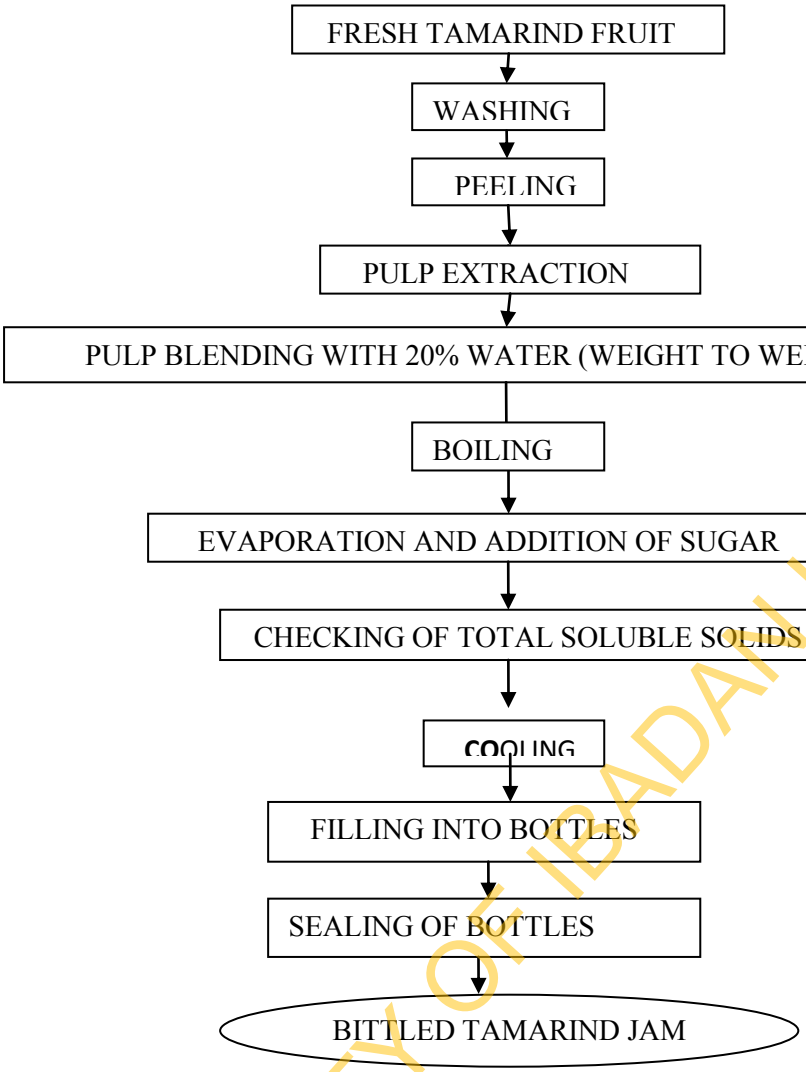


Fig. 2: Flow Diagram of Jam Production from Tamarind Fruits

Plate 1: Ripe fruits of Tamarindus

Determination of pH

The pH of the fruit and the jam samples were determined by inserting the pH electrode into a 50ml beaker containing the samples. The pH meter with pH 7.0 and 4.2 buffer solution were used.

Determination of Total Soluble Solids

The total soluble solids for the fruit and the jam were determined. Drops of the expressed juice of the fruit were placed on the prism of an Abbey desk refractometer and soluble solids reading were then taken. Tea spoons of jam samples were placed on the prism of the refractometer to obtain the soluble solids reading.

Determination of moisture content

The Association of Analytical Chemist Official Method of Analysis (A.O.A.C) (1980) was used. The moisture content cans were placed in the oven for thirty minutes, and were then cooled in desiccators. 5gm of samples were weighed in triplicates into the moisture content cans. The samples were dried at an elevated temperature of 105^0C for 3hours. The samples were then weighed at 30minutes interval until constant weight was obtained. The loss in weight was consequently recorded as moisture content was lost. The dried samples were cooled in desiccators to prevent moisture uptake. The percentage moisture content was calculated as follows:

$$\%\ moisture\ content = \frac{moisture\ content\ x\ 100}{original\ mass\ of\ sample\ x\ 1}$$

Determination of Total Titrable Acidity

Total acidity was determined for the fruit and jam samples as described by (*Ruck,* 1969) with slight modification. 50gm of the sample was blended with 200ml of hot water at 60^0C and made up to 250ml in volumetric flask with distilled water. The aliquot was filtered through cotton wool.100ml of distilled water was added to 50ml of the filtrate followed by titration with standard 0.1N NaOH solution to pH 8.1 using 1% phenolphthalein as indicator. The titration was done in triplicates and the average titre value was determined. Total acidity was expressed as percentage citric acid as follows :

$$total\ acidity\ (\%) = \frac{equivalent\ wgt\ of\ acid\ x\ 0.10\ x\ titre\ x\ 5\ x\ 100}{1000\ x\ 50}$$

Determination of Ascorbic Acid

Ascorbic acid content was determined for the fruit and jam samples as described by (Ruck, 1969) This method depends on the decolourization effect of the extracted ascorbic acid on dye (sodium 2,6 -dichlorophenol indophenols) that was measured photo-electrically using the spectrophotometer. Absorbance was measured at wavelength of 520mm.The extract was prepared by mixing 2gm of blended pulp with 14ml of 0.4% oxalic acid solution. It was filtered through a No 4 what-man filter paper. 0.5ml of the filtrate was added to 4.5ml of dye (sodium 2,6-dichlorophenol indophenols) and the spectro-photometric reading was taken within 15seconds.The concentration of ascorbic acid in mg/100gm sample was estimated from a standard solution.

$$\text{Ascorbic acid mg/100g} = \frac{c\ x\ f\ x\ d\ x\ 100}{s\ x\ 1}$$

Where C = Concentration of ascorbic acid corresponding to particular Absorbance reading in the standard plot gm/100ml
s = Weight of the sample (gm)
f= Dilution factor
d=Dry matter (%)

Determination of Ash Content

5g of dried, milled fruit pulp and 5g of jam samples were placed in separate clean dried and weighed crucibles. The crucibles were placed in a muffle furnace at 525^{0}C and the sample incinerated to produce a white ash for 5hours. The crucible was cooled in desiccators and re-weighed. The Ash (%) was determined as:

$$ash\ (\%) = \frac{weight\ difference\ of\ crucibles\ x\ 100}{weight\ of\ sample}$$

Determination of Heavy Metals and Mineral Elements using Wet Digestion

1ml of each sample was weighed into a digestion tube. 10cm^3 of concentrated HNO_3, 5cm^3 of concentrated H_2SO_4, 5cm^3 of concentrated $HClO_4$, was added to the sample in kjeldahl digestion tube. The tubes were set in the holes of the digestion block heater at a temperature of 350^{0}C to digest the sample till a clear colourless solution was obtained. The digest was transferred carefully to a 100ml volumetric flask and the tube washed thoroughly and then carefully transferred into the 100ml volumetric flask. This was then made up to mark with distilled water. This diluted solution was used to read for any mineral element on Buck 200 Atomic Absorption Spectrophotometer (AAS). Concentration in ppm or % was obtained using the formula below:

$$ppm(metal) = meter\ reading\ of\ sample \times average\ gradient \times dilution\ factor$$

$$\%(metal) = ppm(metal) \div 10000$$

Microbial Analysis

1ml of jam sample was weighed (using analytical mettle balance) into sterile dilution of distilled water. The sample was diluted with distilled water using ten folds serial dilution. The sample was mixed thoroughly to give homogenous suspension with a final concentration of 10^{-1}. 1ml of the diluted sample was inoculated into nutrient agar, Mac conkey agar and potato dextrose agar plates by the pour- plate method to determine the total viable counts, coli form counts and fungal counts. Then the plate was incubated aerobically for 24-48 hours.

Sensory evaluation

15- member panel of assessors with four jam samples were used. Panelists were asked to score samples based on the intensity of organoleptic quality attributes of appearance (colour), taste, flavor and overall acceptability using the 9 point hedonic scale

(Larmond, 1977). Samples were coded and the participating judges were asked to rate them according to their degree of likeness for each of the quality attribute.

Hedonic Scale Test

The degree of liking or disliking was expressed for the jam sample in terms of the sensory quality attributes measured on a nine point hedonic scale. It exhibits the extent of the differences between the jam samples for each sensory quality attributes evaluated. Questionnaire was used for this.

Statistical analysis

The analytical techniques employed include descriptive statistics such as percentages, proportions; t- test and analysis of variance. The least significant difference (LSD) between means were determined based on the method earlier described (Larmond, 1977).

RESULTS AND DISCUSSION

The results of the chemical analyses are presented in Table1 below. Whole tamarind fruit each from Kano and Oyo contains 56% and 90% moisture respectively. There is a significant difference ($p \leq 0.05$) in the moisture contents of the fruits from the two locations.

Ascorbic acid content is low with 2.8mg/100g for Kano and 3.0mg/ 100g for Oyo samples. This agrees with (Lefervre 1971, Ishola *et al*, 1990) who reported that the ascorbic acid in tamarind is very small and it ranges from 2.0-20.0 mg/100g. The most outstanding characteristic of tamarind is its sweet acidic taste, which is due to tartaric acid content ranging from 12.2-23.8%, This is uncommon in other fruits. There is no significant difference ($P \leq 0.05$) in the ascorbic acid contents of the jam samples produced from Tamarind fruits obtained from Kano and Oyo respectively.

Table 1: Physiochemical Composition of Tamarindus indica (L) fruit from two locations in Nigeria

Location	Parameters				
	Moisture Content(g)	TSS (^{0}Brix)	TSS (^{0}Brix) after 120days	Ascorbic acid(mg)	pH
Tamarind from Kano	28^a	13.8^a	13.2 ^{a}	2.8^a	3.70^a
Tamarind from Oyo	45^b	12.5^a	12.0 ^{a}	3.0^a	4.00^a

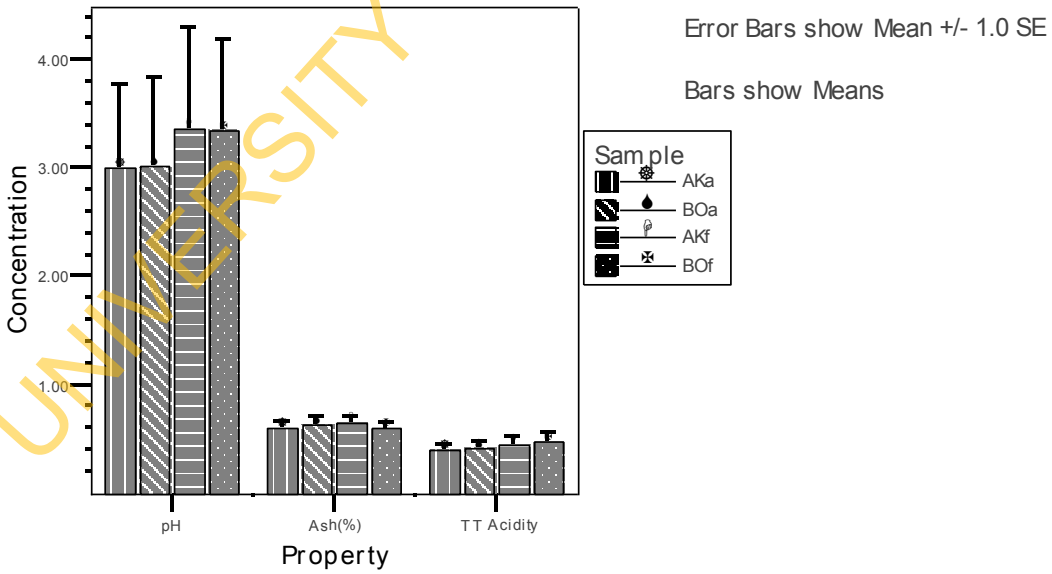
Values not followed by the same superscript in the same column are significantly different ($P \leq 0.05$)

Total Soluble Solids

Total soluble solid (TSS) of tamarind jam decreased significantly with storage duration (Table 1). The interaction between the proportion of pulp, sugar and duration of storage were found to be non- significant ($P \leq 0.05$). It was observed that the value of TSS of the jam samples from Kano decreased from 13.8^0Brix to 13.2^0Brix while that from Oyo decreased from 12.5^0Brix to 12.0^0Brix after 120 days of storage. This could be due to chemical reactions among the organic constituents of the jam. This observation is in line with Ghorai and Khurdiya (1998) who observed that the enhancement in the pulp content and storage duration slightly decreased the TSS of jam. The total soluble solid content values of the samples are comparable with the minimum value set for the quality standards for jam as stated in the food standard order of 1953 (SI 1953 No.691, as amended by SI 1953 No 1307) which states that jam shall contain a percentage of soluble solid of 65^0Brix at the highest **pH**

The characteristics taste of the fruit is determined by the content of sugar and organic acids. The two samples were stored differently at room temperature and refrigerated at less than 10^0C. Tamarind jam from Kano stored at room temperature has pH value of 3.00; while that of Oyo town has 3.02, the refrigerated sample from Kano has the pH value of 3.36 while that from Oyo town has 3.35(Table 1).The non-significant difference in the pH values implies that the jam can keep for long at room temperature without going bad.

Fig 3: Composition of Ash, TTA and pH of Tamarind jam in Oyo and Kano
Aka-Kano ambient temperature



Akf-Kano refrigerated
BOa-Oyo ambient temperature
BOf-Oyo refrigerated

Total titrable acid

Total Titrable Acid is used to measure the acid content of the jam samples. It also shows proper level (46-48%) of acidity required for gel formation. The catabolism of these acids during ripening caused an increase in pH due to reduction in hydrogen ion concentration. The presence of tartaric acid in jam samples is due to the Total Titrable Acid which is used to measure the acid content of the jam samples. Fig 2, shows significant difference between the TTA at ambient and refrigerated temperatures for Oyo and Kano locations (0.42% and 0.40%) and (0.47% and 0.45%) respectively. This implies that artificial pectin should not be added to it due to its unique characteristics and the high level of pectin it contains compared to other fruits like grapes and raspberries which are also used for jam -making.

Ash content

The ash content of the tamarind jam samples from Kano at ambient temperature and refrigeration were 0.60% and 0.65% respectively while that of Oyo at ambient temperature and refrigeration were 0.64% and 0.60% respectively. Fig 3, also shows the non-significant difference ($P \leq 0.05$) at both locations.

Microbial analysis

The results of the microbial analysis of the jam after 24hrs and 48hrs of storage are shown in (Table 2). One hundred percent (100%) tamarind jam from Oyo and Kano at room temperature and refrigerated were (0.33and 3.33cfu/ml) and Oyo has no coli form but Kano has 1.33cfu/ml coli form present in the dilution after 24hrs.One hundred percent (100%) tamarind jams from Kano and Oyo at room temperature has (5.00cfu/ml) rhizobium present, while Kano and Oyo jams under refrigeration has 2.33cfu/ml rhizobium. 100% tamarind jam from Kano at room temperature has no yeast / mould present in the sample while that from Oyo has 0.67cfu/ml.

Table 2: Mean Microbial count in Tamarind Jam at Room and Refrigerated Temperatures(<10^0c).

	24hrs			**Microbes**	**48hrs**		
Location	Types of storage ^{0}C	Coliform (cfu/ml)	Rhizobium (cfu/ml)	Yeast /Mould (cfu/ml)	Coliform (cfu/ml)	Rhizobium (cfu/ml)	Yeast /Mould (cfu/ml)
Kano	Ambient	3.33^a	5.00^a	0.00^b	0.23^a	3.00^a	0.00^a
	Refrigerated	1.33^a	2.33^a	1.67^a	0.00^a	1.00^b	0.33^a
Oyo	Ambient	0.33^a	5.00^a	0.67^a	0.00^b	3.00^a	0.00^b
	Refrigerated	0.00^b	2.33^a	0.33^a	0.00^b	1.67^b	0.00^b

The low microbial count observed in the jam samples may be due to the high total soluble solid content of the jam due to the presence of sugar which doesn't provide a favorable condition for enzyme as well as microbial activities and thus makes the jam desirable before storage.

It was also observed that there was a decrease in the dilution after 48hrs of storage. One hundred percent (100%) tamarind jam from Kano at room temperature has 0.23cfu/ml coli form, 3.00cfu/ml rhizobum and no yeast was present, while refrigerated sample has no coli form present, 1.00cfu/ml rhizobium, and 0.33cfu/ml yeast/ mould present in the dilution. 100% tamarind jam from Oyo at room temperature has zero coliform and yeast and 3.00cfu/ml rhizobium, while refrigerated samples have no coliform and yeast present but have 1.67cfu/ml rhizobium. The high acidity of the tamarind jam will also inhibit the growth of yeast/mould which implies that the jam will have long shelf life. Total viable coliform count for tamarind jam samples after incubation for 24hrs and 48hrs are shown in Table 3 below. The difference in the number of coliform was not significantly different ($p \leq 0.05$) for both ambient and refrigeration except for tamarind jam from Kano at room temperature which is significantly different from others.

Metals Content

The elements detected from the laboratory examination of the pulp samples of *Tamarindus indica. (L)* from Oyo and Kano compared with the UN/WHO maximum allowable concentrations (2008) in human food are shown in Table 3. It is confirmed that the pulp of *Tamarindus indica (L)* for Oyo and Kano States contain biologically important mineral elements such as ; Zinc (0.74mg, 0.60mg), Magnesium (0.68mg, 0.43mg), Cadmium (0.26mg, 0.19mg), Lead (0.55mg, 0.46mg), Manganese (0.94mg, 0.69mg), Copper (0.17mg, 0. 13mg), Iron (0.29mg, 0.16mg), Chromium (0.67mg, 0.56mg), and with a high anti-oxidant capacity associated with high phenolic content which can be considered beneficial to human health. This is also in line with the report of (Parvez *et al.* 2003), that tamarind pulp was rich in minerals and a fair source of iron and that it also excels in riboflavin and is a good source of thiamin and niacin. Some of the above- listed elements are highly toxic and these include Cadmium and Chromium which are heavy metals.

However, since it has been analytically confirmed by comparison with the WHO standard, that the concentrations of each of the elements are comparatively lower; the toxicity level of the pulp is tolerable for human consumption. Furthermore, the pulp has been used for different purposes in many parts of the world without any report of adverse incidents; therefore it is not likely to be toxic or dangerous for human consumption.

Table 3: Concentration of metals in Tamarindus indica (L) pulp and UN/WHO Allowable Concentrations (2008) in Oyo and Kano

Elements	Quantity present in *T. indica* pulp Oyo (ppm/mg)	Quantity present in *T. indica* pulp Kano (ppm/mg)	UN/WHO maximum allowable concentration (ppm/mg)
Magnesium	0.68	0.43	15.0 -30.0
Manganese	0.94	0.69	280 -350
Lead	0.55	0.46	50.0
Iron	0.29	0.16	5.0
Copper	0.17	0.13	2.5 -5.0
Zinc	0.74	0.60	1.5 -3.0
Chromium	0.67	0.56	10.0 -30.0
Cadmium	0.26	0.19	50.0 – 200

Sensory evaluation

The result of sensory evaluation shows different levels of acceptance of various jam samples. There was no difference in panelists' preference for the jam samples from Kano and Oyo on the basis of colour (18.79% apease). 7.54% preferred black currant jam while 9.12% preferred Orange jam in terms of colour. 5.18% of the respondent preferred the taste of the Tamarind jam from Oyo while 12.22% dislike the taste of tamarind Oyo respectively. 23.8% of the panelist did not like Tamarind jam from Kano in terms of taste. Fifty percent of the panelists preferred Tamarind jam from Kano while 25% preferred Tamarind jam from Oyo in terms of taste 66.7%. In terms of overall acceptability, 56.6% like Tamarind jam from Oyo slightly while 66.7% dislike Tamarind jam Kano.

There is no significant difference between sample Tamarind jam from Oyo and Tamarind jam from Kano in terms of colour. There was significant difference in the taste of Tamarind jam from Oyo and Tamarind jam from Kano. There were significant differences between black currant jam and Orange jam in term of taste .The mean score ranges between (7.87-7.93) for blackcurrant jam and orange jam which is significantly higher than the mean score (4.89- 3.67). In terms of flavor, the mean score (8.07) of blackcurrant jam and orange jam was significantly higher ($(p \leq 0.05)$ than the mean score (5.33&4.87) for Tamarind jam from Oyo and Kano respectively. In terms of overall acceptability, 22.12% of the panelist preferred tamarind jam Oyo while 22.03% preferred Tamarind jam Kano.

Table 4: Preference Parameters in Sensory Evaluation of different Jams

Characteristic	Number of panelists	Jam	Mean	S.E	%
Colour	15	Blackcurrant	8.20[a]	0.14	7.54
		Orange	8.20[a]	0.24	9.12
		Tamarind (Oyo)	4.33[b]	0.63	18.79
		Tamarind (Kano)	3.87[b]	0.61	24.54
Taste	15	Blackcurrant	7.87[a]	0.24	9.37
		Orange	7.93[a]	0.23	9.32
		Tamarind (Oyo)	4.87[b]	0.52	17.4
		Tamarind (Kano)	3.67[b]	0.54	23.8
Flavour	15	Blackcurrant	8.07[a]	0.23	8.16
		Orange	8.07[a]	0.23	8.16
		Tamarind (Oyo)	5.33[b]	0.58	20.82
		Tamarind (Kano)	4.87[b]	0.53	22.8
Overall acceptability	15	Blackcurrant	8.33[a]	0.21	7.44
		Orange	8.27[a]	0.18	8.41
		Tamarind (Oyo)	4.73[b]	0.52	22.12
		Tamarind (Kano)	4.33[b]	0.50	22.03

*means with same letter are not significantly different

CONCLUSION

The results of these investigations confirm the great potentials of *Tamarindus indica L* for jam production. Fruits from both Kano and Oyo States were equally good for jam production. There are traces of some heavy metals in the jam produced, the levels are however significantly lower than the UN/WHO allowable standard for human consumption while some of the metals are actually of high nutritional values . There are appreciable levels of vitamin C in tamarind jam which in the nutrition of humans could prevent the manifestation of diseases. Food industries may therefore consider the adoption of these indigenous fruit tree for jam production.

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