



# **Physico-chemical and Organoleptic Evaluation of Drink Produced from Pineapple (*Ananas comosus*) and Tigernut (*Cyperus esculentus*)**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Author AOE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author TOT the analyses of the study. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

Pineapple, one of the most popular tropical fruits is largely desired for its attractive flavor and can be processed into juice. Fruit juice blends can be produced from various fruits or food materials such as tigernut an underutilized tuber, in order to give better quality drink nutritionally and organoleptically. This work therefore evaluated some quality attributes of the beverage produced from tigernut and pineapple. Tigernut and Pineapple fruit were purchased from local market at Ogbomoso. Single strength juice was produced from pineapple fruit while the tigernut milky extract was produced. The pineapple juice was blended with tigernut milky extract in different proportions (95:5, 90:10, 85:15, 80:20 and 75:25%) while 100% pineapple juice served as the control and were analyzed for physico-chemical composition and sensory evaluation (Colour, flavor, taste and overall acceptability). The data obtained were subjected to statistical analysis. The results showed that the physico-chemical properties of juice compared relatively well with the control and sensory evaluation showed that all the juice samples were well acceptable in terms of colour, flavour, taste and overall acceptability. The juice blend could be recommended to every household for its nutritional and therapeutic properties.

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## 1. INTRODUCTION

It has been recognized for many years that fruits continue to undergo biochemical changes even after harvest until spoilage occurs by microorganisms. This contributes to high post-harvest losses. Most fruits are eaten as desserts and they can be processed into liquid product which includes fruit juices, fruit drinks and wines. In processing, fruits are converted into more stable products through unit operations, such as cleaning, soaking size reduction, peeling, mixing, and heat treatment [1].

Juice is a liquid that is naturally contained in fruit or vegetable tissue. It is one of the most popular drinks to go with breakfast in the morning and at every meal of the day [2]. Fruit juice blends can be produced from various fruits, this combine all the basic nutrients present in these different fruits for use when combined. The blends usually gives a better quality juice nutritionally and organoleptically [3].

Pineapple (*Ananas comosus*) has been recognized as one of the most popular of the non-citrus tropical and subtropical fruits, mainly because of its attractive flavor and refreshing sugar-acid. It has a proximate composition of 81.2 – 86.2% moisture, 13 – 19% total solid of which sucrose, glucose and fructose are the main compositions, 0.4% fibre and a rich source of vitamin C [4]. Pineapple also contains polyphenolic compounds and possesses antioxidant activity. Its pulp is juicy and fleshy with the stem serving as a supporting fibrous core. It is an excellent source of antioxidant, vitamin C which is required for healthy development. Pineapple fruit can be consumed fresh or processed in various forms and the juice is a popular product due to its very pleasant aroma and flavour [5]. The juice is consumed around the world mostly as a canning industry byproduct, in the form of single strength, reconstituted or concentrated and in the blend composition to obtain new flavors in beverages and other products [6]. Tigernut extract, can therefore serve as an excellent blend with pineapple juice.

Tigernut is an important food crop for certain tribes in Africa. It can be eaten raw, baked as a vegetable, roasted or dried and ground to flour. The flour is sometimes mixed with sorghum to

make porridge, ice-cream, sherbet or milky drink. It is mostly consumed raw as snack without knowledge of the food and nutritional quality [7]. It has also been found to possess good therapeutic quality. Due to the inherent health benefit of tigernut, its milky extract has been suggested could serve as a good alternative to cow milk in the production of yoghurt [8]. Various tigernut's food recipes and preparation methods are well documented. The best-known application of tiger nut in food technology is the production of "horchata de chufa" (tiger nut milk) [9]. It has been used successfully as a flavouring agent in ice cream. Flour of roasted tiger nut is sometimes added to biscuits and other bakery products [10], in the making of oil, soap, and starch extracts [11] as well as in the preparation of kunnu [12]. Kunnu - a local beverage in Nigeria is a nonalcoholic beverage prepared mainly from cereals (such as millet or sorghum) by heating and mixing with spices (dandelion, alligator pepper, ginger, licorice) and sugar. To make up for the poor nutritional value of kunnu prepared from cereals, tiger nut was found to be a good substitute for cereal grains. A similar beverage is also available in Ghana which is prepared from roasted and nonroasted tiger nut [8]. Tigernut has been for many years one of the underutilized food crops in Nigeria. It has been reported as a very important food crop that has great potential in managing, preventing and eliminating malnutrition (macronutrient and micronutrient deficiencies) or food insecurity problems. It has been demonstrated by nutritionist that the major nutritional problems could be solved through exploitation of the nutrition and economic potentials of the local food resources [13].

Tigernut an underutilized crop and pineapple fruits have great potentials for domestic and commercial purposes. There is no documentation of a successful product made from tigernuts and pineapple in the Nigerian market. A successful product from it will offer a benefit that is perceptible and valued by the consumer. However, tigernut is still one of the least popular tubers in Nigeria and hence the need for this research which intends to evaluate, promote production and utilization of tiger nuts and pineapple. The objective of this study is to evaluate the physico-chemical and sensory properties of beverage produced from the blends of tigernut and pineapple.

## 2. MATERIALS AND METHODS

### 2.1 Materials

Fresh raw tigernuts and pineapple and all the other ingredients were purchased from local market in Ogbomoso, Oyo State, Nigeria. Other equipment and processing of the juice was done at Ibrahim Owodunmi Food Processing Laboratory, Ladoke Akintola University of Technology (LAUTECH) Oyo State, Nigeria.

### 2.2 Preparation of Pineapple Fruit Juice

The fruits were selected and washed thoroughly with clean water. They were peeled with sterile stainless knife, cut into small pieces of about 3-4 mm thick and the juice extraction using a blender. The extracted juice was filtered by passing through a sterile muslin cloth. The juice was bottled in an airtight screw cap sterilized glass bottles and refrigerated at 5°C prior to analysis. Preparation of pineapple juice is shown in Fig. 1 [14].

### 2.3 Preparation of Tigernut Milk Juice Extract

Preparation of tigernut extract was done by picking out foreign and bad nuts that could affect the taste of the drink. The tigernut was washed, rinsed in distilled water. It was then soaked overnight to soften the fibre. This was washed in two changes of water, drained and 900 g of soaked tigernut were blended into paste with 2 L of warm water in electric blender and slurried. Distilled water was used during the blending and slurring process. The slurry was filtered with the aid of a clean damp muslin cloth to separate the extract from the mash and the filtrate obtained was transferred into sterilized plastic bottles, corked and stored in the freezer (for not more than three days) prior to analysis and use. Preparation of tigernut milk is shown in Fig. 2 [8].

### 2.4 Preparation of Tigernut/Pineapple Juice Blend

The pineapple juice was blended with tigernut extract in varying proportion such as 100:0, 95:5, 90:10, 85:15, 80:20 and 75:25%. The blends were homogenized, bottled and pasteurized at 80°C for 7 minutes, cooled to room temperature and analysed for physicochemical and sensory properties (Table 1).

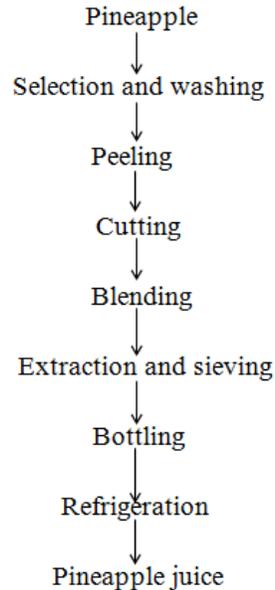


Fig. 1. Production of pineapple juice [14]

## 2.5 Physico-chemical Analysis of Samples

### 2.5.1 pH

The pH of the juice was determined using a digital pH meter according to AOAC method [15].

### 2.5.2 Determination of total soluble solids

This was carried out by using the glass slide of the refractometer (Atago hand refractometer N<sub>1</sub>, 0-32%) which was cleaned with water and wiped dry with a clean napkin. A smear of the sample was made on the slide of the refractometer and the lid replaced. The reading was taken at the graduated mark. This reading indicates the total soluble solids value of the sample and was recorded in degree brix [15].

### 2.5.3 Density

The density ( $\rho$ ) of the samples which is the mass per unit volume were measured at 25°C using 25 ml pycnometer [16] the pycnometer was previously calibrated with distilled water and expressed as g cm<sup>-3</sup>.

### 2.5.4 Specific gravity determination

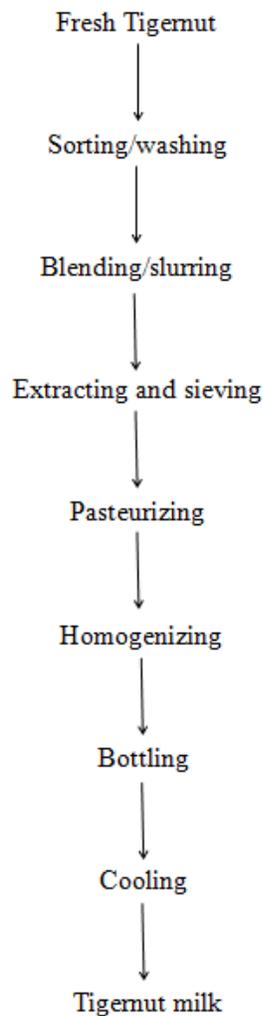
The specific gravity of the sample was determined using the pycnometer-specific gravity bottle. Specific gravity is the ratio of the density

**Table 1. Formulation of pineapple/tigernut juice blends**

| Sample | Pineapple juice % | Tigernut extract % |
|--------|-------------------|--------------------|
| A      | 100               | 0                  |
| B      | 95                | 5                  |
| C      | 90                | 10                 |
| D      | 85                | 15                 |
| E      | 80                | 20                 |
| F      | 75                | 25                 |

of the juice sample to the density of a reference which is water. Specific gravity represents a ratio and is therefore dimensionless [17].

thereafter measured by titration method using 2,6-dichlorophenol indophenol dye as described by Vasant et al., [18].

**Fig. 2. Preparation of tigernut milk extract [8]**

### 2.5.5 Vitamin C

The vitamin C present in the samples was extracted with 0.5 per cent oxalic acid and

### 2.5.6 Sensory evaluation

Sensory evaluation was carried out with 20 panelists from Food Science and Engineering. Each panelist was served the juice samples on a rectangular plastic tray. The juice was coded with a three-digit number prior to testing. Water was provided for rinsing between the samples. Panelists were required to evaluate the colour, flavour, taste and overall acceptance of the juice using the 9-point hedonic scale with 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely [19].

### 2.6 Statistical Analysis

The results of the experiment was subjected to analysis of variance (ANOVA) and the mean was separated with the use of Duncan's multiple range test to detect significant difference ( $p < 0.05$ ) among the sample values using the statistical package for the social science (SPSS).

## 3. RESULTS AND DISCUSSION

### 3.1 Physico-chemical Properties of Juice

The Physico-chemical Properties of Juice is shown in Table 2. The pH ranged from 5.80 to 6.05 with sample A (100% Pineapple) having the lowest value while sample F (75% pineapple+ 25% tigernut) having the highest value. The result showed that there was significant increase in the pH of the juice blends with the increase inclusion of tigernut milk. This study agrees with the work of Sanful [8] and Ade-Omowaye et al. [20] who reported increase in pH values as the content of tigernut increased in yoghurt and for tigernut composite flour for bread respectively. The results is a bit higher than Harris et al., [21]

report, who reported that fruit and vegetable juice falls within the range of 3 – 5. There were significant difference ( $p < 0.05$ ) in the pH values for the samples A, C and F. Several researchers have reported fruit juices with different pH values. Pineapple has been reported to contain a pH range of 3.7 – 4.5 by Frazier and Westhoff [22]. Adubofuor et al., [23] reported a range of 4.82 – 4.99 for cocktail juices, Ndife et al., [24] observed a range of 3.23 – 4.08 for different brands of orange juices, as well as reported by Emelike and Ebere [25] for fresh cashew apple juice.

The density of the juice ranged from 1.11 to 0.98 g/cm<sup>3</sup> with sample A (100% Pineapple) having the highest value while sample F (75% pineapple+ 25% tigernut) having the lowest value. The result showed that there was decrease in the density of the juice with the inclusion of tigernut milk. This result is similar to the report of Gratao et al., [26] that the density of passion fruit juice decreased exponentially with moisture content and decreased linearly with temperature. The significant decrease in the density of the fruit blends with increasing level of tigernut milky extract may be due to increase fat content in the tigernut.

This was due to the fact that density of fat is markedly lower than that of water and fat content of tigernut milk might have had significant effect on density of tigernut milky extract [27]. The density of liquid is defined as mass per unit volume, plays an important role in heat, mass and momentum transfer phenomena in several food processing unit operations. The density of liquid foods depends on the nature and amount of solvent, solute (sugars, organic acids and other macromolecules) and their interaction with

solvent (water). The magnitude of density of each food constituent is different which lead to change in magnitude of density of food with change in mass fraction of food constituents. There is no significant difference ( $P > 0.05$ ) between sample A and F.

The specific gravity of the juice varied from 1.00 to 1.12 with sample A (100% Pineapple) having the highest value while sample F (75% pineapple+ 25% tigernut) having the lowest value. The result showed that there was decrease in the specific gravity of the juice with the inclusion of tigernut milk. The results of the specific gravity are in agreement with those of [28], in case of development of beverages using fruit juice pulp, separated milk and reconstituted skim milk. There is no significant difference ( $P > 0.05$ ) between sample A and B but significantly different from samples D and F.

The total soluble solid ranged from 11.76 to 14.81 with sample A (100% Pineapple) having the lowest value while sample F (75% pineapple+ 25% tigernut) having the highest value. The Samples with higher tigernut milky extract samples contain higher amount of total solid and this might be due to the added residue from the tigernut milk. Tiger nut is reported to be rich in sucrose (17.4 - 20.0%) by Kordylas [29]. The result is higher compared to the range of 7.22 – 9.28% for cocktail juices [23], 8.17 – 9.91% for soy-carrot flavoured with beetroot [30] and 9% for fresh beetroot juice reported by Emelike et al., [31]. It is in close to 11.80% for different brands of orange juice samples as reported by Ndife et al., [24]. There is no significant difference ( $P > 0.05$ ) between samples C - F.

**Table 2. Physico-chemical properties and Vitamin C content of the juice blend**

| Sample | pH                      | Density (g/cm <sup>3</sup> ) | Specific gravity         | Total soluble solid      | Vitamin C (mg/100g)      |
|--------|-------------------------|------------------------------|--------------------------|--------------------------|--------------------------|
| A      | 5.80±0.000 <sup>a</sup> | 1.11±0.023 <sup>b</sup>      | 1.12±0.024 <sup>b</sup>  | 11.76±0.004 <sup>a</sup> | 28.35±0.016 <sup>d</sup> |
| B      | 5.80±0.000 <sup>a</sup> | 1.09±0.071 <sup>b</sup>      | 1.10±0.074 <sup>b</sup>  | 11.85±0.877 <sup>a</sup> | 27.61±0.016 <sup>c</sup> |
| C      | 5.90±0.000 <sup>b</sup> | 1.06±0.007 <sup>ab</sup>     | 1.08±0.007 <sup>ab</sup> | 13.30±0.661 <sup>b</sup> | 26.75±0.014 <sup>b</sup> |
| D      | 5.90±0.000 <sup>b</sup> | 1.04±0.044 <sup>ab</sup>     | 1.01±0.021 <sup>a</sup>  | 13.30±0.005 <sup>b</sup> | 26.47±0.014 <sup>a</sup> |
| E      | 6.00±0.000 <sup>c</sup> | 1.02±0.002 <sup>ab</sup>     | 1.06±0.030 <sup>ab</sup> | 13.38±0.004 <sup>b</sup> | 28.54±0.015 <sup>e</sup> |
| F      | 6.05±0.070 <sup>c</sup> | 0.98±0.016 <sup>a</sup>      | 1.00±0.016 <sup>a</sup>  | 14.81±0.012 <sup>b</sup> | 28.38±0.014 <sup>d</sup> |

*Values are expressed as mean ± standard deviation of duplicate determination. Mean with the same superscript along the same column are not significantly different ( $p > 0.05$ )*

*Sample A= 100% Pineapple; Sample B= 95% Pineapple + 5% Tigernut; Sample C= 90% Pineapple + 10% Tigernut; Sample D= 85% Pineapple + 15% Tigernut; Sample E= 80% Pineapple + 20% Tigernut; Sample F= 75% Pineapple + 25% Tigernut*

**Table 3. Sensory evaluation of juice**

| Sample | Colour                   | Flavor                    | Taste                    | Overall acceptability   |
|--------|--------------------------|---------------------------|--------------------------|-------------------------|
| A      | 8.70±0.483 <sup>b</sup>  | 7.60±0.0843 <sup>b</sup>  | 7.70±0.949 <sup>a</sup>  | 8.00±0.471 <sup>b</sup> |
| B      | 8.70±0.674 <sup>b</sup>  | 8.00±0.0675 <sup>bc</sup> | 8.40±0.843 <sup>ab</sup> | 8.20±0.632 <sup>b</sup> |
| C      | 8.30±0.823 <sup>b</sup>  | 8.20±0.823 <sup>bc</sup>  | 8.40±0.699 <sup>ab</sup> | 8.20±0.422 <sup>b</sup> |
| D      | 7.80±1.032 <sup>ab</sup> | 7.90±1.032 <sup>b</sup>   | 8.20±0.633 <sup>ab</sup> | 8.20±0.632 <sup>b</sup> |
| E      | 7.80±1.135 <sup>ab</sup> | 7.90±1.135 <sup>b</sup>   | 8.10±1.370 <sup>ab</sup> | 7.90±1.100 <sup>b</sup> |
| F      | 7.30±1.337 <sup>a</sup>  | 6.60±1.337 <sup>a</sup>   | 6.60±0.843 <sup>a</sup>  | 6.70±0.949 <sup>a</sup> |

Values are expressed as mean ± standard deviation of duplicate determination. Mean with the same superscript along the same column are not significantly different ( $p>0.05$ )

Sample A= 100% Pineapple; Sample B= 95% Pineapple + 5% Tigernut ; Sample C= 90% Pineapple + 10% Tigernut; Sample D= 85% Pineapple + 15% Tigernut; Sample E= 80% Pineapple + 20% Tigernut; Sample F= 75% Pineapple + 25% Tigernut

The vitamin C of the juice varied from 26.47 to 28.54 (mg/100 g) with sample D (85% pineapple+ 15% tigernut) having the lowest value while sample E (80% pineapple+ 20% tigernut) having the highest value. Vitamin C content of this study differ from the result of vitamin C values of pineapple juice (32.50mg) and orange juice (67.758 mg) reported by Awsi and Er-Dorcus [32] and Muhammad et al., [33] respectively. The relatively high value for vitamin C reported in this study agreed with literature which stated that fruits have been shown to a good source of vitamin C [2].

Vitamin C is the popular antioxidants has been reported to play a crucial role in preventing peroxidation damage in the biological systems [34,35]. It is the principal vitamin supplied by fruits in the diet. An adult human being on average requires about 50mg of vitamin C per day [36] and the blends produced in this study will be able to supply a substantive amount of such requirement. The vitamin C content in fruit and vegetables can be influenced by some factors such as: genotypic differences, pre-harvest conditions, maturity stage, harvest methods, and post-harvest handling system. There is significant difference ( $P < 0.05$ ) between samples.

### 3.2 Sensory Evaluation of Juice

The statistical analysis revealed that there were no significant difference ( $p>0.05$ ) in the colour of all the pineapple/tigernut juice samples except samples F as shown in Table 3. The colour ranged from 7.30 to 8.70 with sample A (100% Pineapple) having the highest value while sample F (75% pineapple+ 25% tigernut) having the lowest value. Samples A having the highest value shows that the panelists prefer the colour of 100% pineapple juice compared to the pineapple/tigernut juice. Apart from sample F,

other sensory scores for colour is in close agreement with the report of Ndife et al., [24], who reported a range of 5.14 – 8.35 for different brands of orange juice samples. Sample F showed the least acceptability in all the sensory attributes such as colour, flavour, taste and overall acceptability [34]. This may be related to the high content of tigernut milk blends. Some fruit juices that have been produced locally and reported by researchers to obtain high sensory value are cashew apple juice with sensory score range of 3.50 – 4.56 on a 5 – point hedonic scale as reported by Emelike and Eberé [25] and soy/carrot/beetroot with the acceptable range of 6.05 – 7.80 on a 9 – point hedonic scale reported by Banigo et al., [30].

### 4. CONCLUSION

Pineapple/tigernut juice blends were successfully produced and analysed for physico-chemical, vitamin C and sensory properties. It was observed that there was increase in the pH and total soluble solid and decrease in the density and specific gravity of the juice as tigernut milk is been included. These blends will also serve as a good source of vitamin C. All the sensory attributes of the pineapple/tigernut juice blends were well accepted. Pineapple/tigernut juice should be recommended to every household due to the inherent quality attributes.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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